Royal Commission

on

Electric Power Planning

LEGISLATIVE AND GOVERNMENTAL
ACTIONS BEARING ON THE DEVELOPMENT
OF THE SOLAR HEATING ALTERNATIVE

Chairman, Dr. Arthur Porter

Ontario

HOOPER AND ANGUS ASSOCIATES LTD.
CONSULTING PROFESSIONAL ENGINEERS
980 YONGE STREET, SUITE 402, TORONTO, CANADA M4W 2J9 • TELEPHONE (416) 961-4151

LEGISLATIVE AND GOVERNMENTAL ACTIONS BEARING ON THE DEVELOPMENT OF THE SOLAR HEATING ALTERNATIVE

A REPORT TO THE
ROYAL COMMISSION ON ELECTRIC POWER PLANNING

JANUARY 1978

TABLE OF CONTENTS

PAGE

I. INTRODUCTION

The purpose of this study is to examine the legislative and governmental barriers to the rapid development and implementation of solar energy as a viable alternative to conventional energy resources for space and water heating.

Taken overall, about one third of all energy used in Canada goes to heating, another third to transportation, and the balance to other uses including industrial and public utility power generation. In the past fifteen years residential space heating in Ontario provided by electricity has increased from 1 percent to 25 percent in all newly constructed homes. (1) In the future, an increasing proportion of the heating load can be expected to move to the electrical source and substantially influence the demand on utilities. The extent of this movement will depend in part upon the rate and type of development of alternative renewable energy resources for space and water heating.

Of the alternative energy resources available, solar energy appears to offer the best prospects for rapid development. An adequate technology exists and the economics, in terms of life-cycle costs, are near the balance point with fossil fuels and electrical alternatives. Indeed, the economics are so near to a balance as to make the influence of government policy and legislation quite critical.

The kind of legislation that is required would change existing laws where needed and create new ones where provisions in present laws do not fully consider the requirements of solar heating devices. The utilization of solar energy is presently controlled by laws and regulations that were written at a time when the potential for solar heating was not fully recognized. Legislation should therefore attempt

to adapt solar technology to present legal, political, social and economic processes.

The conventional type of solar heating system used for space and water heating is designed to produce low grade heat, and consequently, relies heavily on energy efficient building design and conservation practices on the part of the occupants in order to operate with maximum success. Therefore, in designing incentive programs to stimulate the widespread use of solar heating, consideration should be given to extending such inducements to include the implementation of conservation measures as well.

Insofar as solar heating systems are viewed as alternative or supplementary heating systems, they will impact on, and be impacted by the highly complex building industry. This industry, composed of many component industries, would include manufacturers of equipment and building materials, contractors, architects and engineers. There is a high degree of fragmentation in all sectors and most functions of the industry, giving rise to different biases and different criteria for decision making. To various degrees in different segments of the building industry, the acceptance of solar heating systems will be dependent upon such factors as:

- general awareness of technical and economic feasibility;
- availability of qualified designers;
- availability of solar system components;
- availability of qualified contractors to install the system;
- some assurance of product reliability;
- awareness as to the manner in which solar skyspace will be protected;

- availability;
- guaranteed acceptability for insurance; and
- availability of qualified servicing. (2)

The utility company will share these concerns of the building industry, and must consider as well a number of other impact criteria. These include the direct and indirect effects solar heating and cooling systems may have on the utility peak demands and on the load factors. (3) Because solar systems incorporate thermal storage,utilities may find them very useful in their load management programs. They may also find that some types of solar heating system, such as those with seasonal thermal storage, have characteristics particularly favourable to the public utility. Indeed it may be that the public utility will see it to be in their own interests to assist in the financing of suitable units and to participate in their marketing.

Consumers, both private and corporate, will normally be mainly concerned with the short term economics of solar heating system ownership, with the capital costs, the reliability, the convenience, and the aesthetic and social acceptability of the equipment.

Governments should be concerned with the long term impacts on the economy, on the ecology, and on the pollution and safety, and of course dominantly upon the available energy supplies in the future. Government can be expected to take legislative and administrative measures to achieve a favourable impact by enabling and encouraging industries, utilities and consumers to use appropriate solar systems.

This report addresses all of these matters, and makes suggestions regarding specific measures and their impacts.

II. GOALS AND OBJECTIVES OF A SOLAR HEAT UTILIZATION PROGRAM

1. INTRODUCTION

Incorporating technological innovation into an industrial framework is a complex process. A new industry, as a fledgling producer and distributor, faces competition from better capitalized and subsidized institutions. It may lack credibility and acceptance, and find it difficult to gain institutional support and representation.

Solar heating technology is at the stage now where some sort of representation by a single administrative office (possibly under the Ministry of Energy) would give the kind of organization needed to bring various sectors of the solar heating industry together. These would include researchers, manufacturers, builders, contractors, architects, engineers and lawyers. Such an office, working either directly under government authority, or independently representing all solar heating supporters, would make solar heating in Ontario more visible and available, and make its acceptance more rapid and wide-spread.

It is useful to postulate the existence and functions of such an office in order to discuss the impact of solar energy under a favourable but realistic circumstance.

2. A SOLAR HEAT UTILIZATION PROGRAM

2.1 Objectives

Whether a "Solar Heat Utilization Office" is directed solely by government, or acts on orders from an elected board of directors comprised of members from within the solar heating industry, the government could devise a "Solar Heat Utilization Program" designed to accomplish the particular objectives agreed upon by the central office.

The objectibes of such a program would include advising the public of the choices available for space and water heating and make them aware of the particular trade-offs associated with each alternative. Under government direction, the office would encourage conservation and the use of solar heating where possible and cost-effective. It would be able to act either upon petition by landowners, or on its own initiative, upon determining that energy conservation would be served by the provision of measures to promote solar energy - such as guaranteeing obstruction-free solar skyspace, and revision of building codes and zoning ordinances. When acting on its own initiative the office would be required to give notice of its plans to affected persons and the general public, and hold public hearings. (1) Privately negotiated express easements and restrictive covenants concerning solar skyspace might be recorded and administered by the office, and might not be valid until approved by the office. This would ensure that applicants for solar skyspace easements had given consideration to all factors defined in the terms of the contract.

2.2 A Major Public Information Program

Part of the complete Solar Heat Utilization Program could be dedicated to a mass public information campaign. The media, education, solar heating demonstrations and fairs, person-to-person communication, and other programs could be designed to increase public awareness of the realistic capabilities of solar heating. People would not only be informed of the solar alternative to space and water heating, but would also be instructed in conservation practises and the efficient utilization of energy resources.

Meetings with architects, builders, real estate salesmen, bankers and building owners and others involved in delivering solar heating equipment would increase the awareness concerning solar heating systems as a viable alternative to conventional heating systems. Feedback from public and industry sources concerning hesitations and doubts, and changes in attitude, should be obtained and employed as a basis for planning public information.

All information concerning economic and financial incentives, and laws designed specifically for solar heating systems should be made readily available. Education concerning life-cycle costing could be promoted via banks, schools, media, etc. Programs designed by the central Solar Heating Office in collaboration with school systems, public and private broadcasting systems, the news media, labour unions, environmental groups, business and industrial journals, etc. could be used to disseminate information in a manner that could promote a comprehensive understanding of the issues, and allow for intelligent discussion of the options presented. (2)

Pamphlets designed to provide the consumer with information concerning the advantages and disadvantages, the economics, life cycle costing and the mechanics of the solar heating equipment should be prepared to "assure that facts prevail over mythology". (3)

2.3 Training Programs

In conjunction with the Ministries of Colleges and Universities, Labour, Industry and Tourism and other pertinent departments, the Solar Heating Program could include training of teachers, special tradespeople - plumbers, pipefitters and carpenters to familiarize each group with the equipment constituting a solar heating system and methods of installation. Pilot educational operations could be encouraged in specific regions of the Province to assure that necessary training resources are available. A task force of industry, labour, builders, architects, employment service personnel and educators could develop locally relevant patterns of training. The local Solar Heating Office could implement, when the development was mature enough, a balanced education, placement and information program. (4)

2.4 A Statute for a Solar Heat Utilization Program

The purpose of a Solar Heat Utilization Program might best be expressed by a statute expressing that it is in the public interest to study solar heating, to establish policies for provincial and municipal actions, to educate the general public and governmental officials, and to encourage the use of solar heating in public and private residential, commercial, and industrial buildings where such use would promote the efficient utilization of energy resources. (5)

The statute should give an outline of the program in which the province is directed to:

a. make studies, establish policies, and plan for the efficient widespread use of solar heating systems;

b. develop model regulations for municipalities relating to structures and uses, where it is efficient and cost-effective to utilize solar heating systems to provide heating requirements;

c. develop model regulations for municipalities to encourage the establishment and protection of solar skyspace;

d. develop an education program in which the public and government officials are informed of techniques for conservation, and of the available solar heating systems;

e. develop a data bank, and methods for collection and dissemination of information on solar heating systems, weather, solar radiation data, and the results of any activities carried out by this government and others;

f. maintain a library on solar heating systems, existing equipment and design of solar systems; and serve as a clearinghouse for information relating to solar heating systems and for referring citizens, builders, municipalities, and others to the appropriate sources of information;

g. establish standards within ninety days of passage of this statute to review and approve provincial and municipal construction plans for buildings where the use of solar heating systems is feasible;

h. develop analytical methodologies by which economic and technical judgements can be made on the extent to which solar heating can supply the heating requirements of a facility in terms of life cycle cost;

i. encourage the use of life cycle cost analysis in feasibility studies of solar installations and developments;

j. assess designs of all government buildings to be built for feasibility and cost-effectiveness of utilizing solar heating systems where appropriate, recommend the use of solar installations or provisions for future use of solar heating and

k. demonstrate a number of solar heated, and combined solar heated systems with auxiliary back-up systems in residential and commercial application. (6)(7)

2.5 Municipal Comprehensive Plans to Include Solar Heat Utilization

Often, municipalities have long term development plans which serve as a guideline for future development, and aid in shaping the character and individuality of each community according to its particular custom. In addition to a solar heating program, provincial planning statutes could require every municipality which already has, or is preparing a longterm comprehensive plan (i.e. for physical development, community development, land or energy use), to include a solar heating system element in the plan. Such an element would be consistent with the objectives of the Solar Heat Utilization Program.

The statute could require the solar heating element to:

"a. define standards which describe types of uses, location and areas, buildings, structures and developments where solar (heating) systems are to be encouraged or required, and the means of encouragement, conditions where encouraged and required, and methods of ensuring compliance;

b. describe protected solar skyspace locations and methods of protecting solar skyspace for actual, proposed and designated solar collectors; and

c. describe designated locations for collectors which encourage the use of solar (heating) systems and minimize interference from potential construction."(8)

The solar heating system element of the statute should be integrated with land use, energy conservation, and other elements of the plan so as to ensure a comprehensive consideration of all the issues. In addition, it should require that the municipality not issue any construction or development permit, or enact or amend any ordinance, unless these elements are consistent with the solar heating element. Municipal solar heating elements adopted pursuant to such a statute should contain a findings section and a policies section.

The findings section of the statute, based on adequate study and evidence, would typically report on any new developments in the area of;

a. conservation, or solar heating technology, showing the feasibility of solar energy in its various applications;

b. new districts designated for solar heating use and how their cost-effectiveness compares with already established areas;

c. the reduced burden on utilities resulting from solar energy use; and

d. the decreased reliance on conventional energy resources; and similar findings as are applicable at the time in the municipality. (9)

The policies section of the municipal solar heating element should declare a general policy of encouraging solar heating where physically and economically feasible. Actions would be taken to eliminate impediments and provide inducements for the use of solar heating through land use ordinances and other regulations and programs.

Specific policies should include:

"a. limiting encouragement to those systems which are cost effective on a long-term or life cycle basis;

b. amending existing municipal ordinances so as to remove impediments to solar (heating) systems and a listing of the principal kinds of ordinances where impediments are likely;

c. protecting solar skyspace through height and placement restriction on structures;

d. creating special solar districts where solar (heating) use is encouraged based on relevant enumerated criteria;

e. enacting encouragements to solar energy use in all new construction and in reconstructed and altered structures;

f. revising municipal building codes to remove impediments to solar (heating) use; and

g. enacting a property tax exemption for solar (heating) systems." (10)

2.6 Solar District Zoning Ordinance

In conjunction with a municipal comprehensive plan, and the Solar Heat Utilization Program, the province could require municipalities to create zones or districts where available solar heating systems are encouraged or required

and to define the conditions in those zones under which solar heating systems and solar skyspace shall be provided. All administration would be carried out locally and the Solar Heating Office would act as a consultant to aid in meeting the Program's objectives.

The purpose of the legislation would be to create special solar energy use districts which would require maximum use of solar resources which in turn would conserve scarce conventional energy resources and reduce pollution. The districts should be designated: Mandatory Solar Use Districts; Affirmative Solar Use Districts; and Other Solar Use Districts. These may overlay or be superimposed upon existing districts and classifications.(11)

"In Mandatory Use Districts, if solar systems are available. they shall be required in all new construction, or major structural renovations, or when conventional energy systems are replaced, unless a solar installation is not economically justified on a life-cycle basis. In commercial or industrial uses or structures, solar systems would be reqired when conventional energy systems were obsolete, fully depreciated, wasteful or energy resources, or uneconomical. This would apply to both solar heating and solar cooling systems.

In Mandatory Use Districts the following uses and physical regulations should apply:

a. setback lines should be related to the effective use of solar heating systems on actual, planned and potential structures, and uniformity of setback lines should be sacrificed for the sake of efficient solar utilization;

b. height restrictions should be inapplicable to the placement of collectors on structures, and regulations governing expansion, alterations or new uses for nonconforming structures or uses should not be applicable to solar system installations;

c. aesthetic and design requirements (should) be inapplicable to solar systems designed to maximally conform with such requirements, and bulk, open space, and floor area calculations (should) not consider land or space utilized by solar systems, except to the extent that (such) systems use more than fifty percent of all utilized space or land." (12)

The applications of these provisions, while benefitting solar energy users, may adversely affect other property users. Thus, such provisions should not apply if a person petitions the municipality and it finds that:

"a. the use of solar systems for another owner or user would be made substantially infeasible and no remedial actions have been taken;

b. the petitioner has not made a significant attempt to design an economical solar heating system which complies with the underlying zoning ordinance;

c. light or air to the landowner or land user would be so impaired as to constitute a health hazard; or

d. a significant hazard or danger to any person would be created, a nuisance would be established, or the use of land or structures would be overstressed beyond capacity." (13)

Where a cost-effective installation is designed and actually located, or proposed, and where an owner or user agrees to pay any costs of solar skyspace acquisition when prorated over a twenty year period, with interest, then the municipality should protect the skyspace surrounding the collector. This might be accomplished through the power of eminent domain (discussed in section IV - 4) purchase or regualtion, provided the use of eminent domain does not conflict with existing conforming structures or skyspace designated in a municipal comprehensive plan for construction. (14)

In an Affirmative Solar Energy Use District, if the owner of an actual or proposed solar collector petitions the municipality for protection of solar skyspace, the municipality shall comply under the same circumstance as defined above for Mandatory Use Districts.

In districts designated as Other Solar Use Districts, the municipality should use its descretion in protecting skyspace for solar installations that are cost-effectively designed and located, upon petition by an owner or user who agrees to pay the costs of skyspace acquisition.(15)

In Other Solar Use Districts, exceptions form restrictions on use and physical regulations should be granted where the municipality finds that the installation would not be cost-effective unless the exceptions were granted.

The exceptions should be denied for the same reasons that the municipality would deny application of similar regulations in the Mandatory or Affirmative Solar Districts. (16)

" The solar district ordinance should contain a procedure for granting variances from the requirements of the ordinance upon the showing of:

a. substantial hardship;

b. use of other non-conventional energy sources on site;

c. technical or economical infeasibility of a solar (heating) system;

d. use of energy from off-site sources of non-conventional energy;

e. failure of the municipality to adequately protect solar skyspace; or

f. substantial injury to the public health, safety or welfare." (17)

3. CRITERIA FOR EVALUATION OF NEW LAWS AND PROPOSALS FOR SOLAR ENERGY

In drawing up any new legislation for solar heating purposes, the laws should accomplish the following:

"a. protect users from a shadow;

b. promote solar (heating) development and use;

c. be politically acceptable at all levels, especially local;

d. complement but not replace existing remedies such as covenants and easements;

e. avoid additional direct expense;

f. pragmatically solve specific problems arising in use, not broad hypothetical problems;

g. minimize new bureaucratic structures and red tape;

h. avoid litigation between members;

i. avoid unnecessary burdens to property owners and developers; and

j. provide flexibility for changing solar technology." (18)

4. CONCLUSION

Possibly the most benefit to be drawn from the proposals under a Solar Heat Utilization Program is the unifying effect on the various sectors of the solar industry. Under a central administration, all parties concerned - including builders, contractors, engineers, architects, manufacturers, researchers and lawyers - would have a common communicating line which would ensure that all positions were evaluated and included in any comprehensive plan. This would give the solar industry more control over its future development and, if given any governmental representation, the industry could have more direct influence on the passing of legislation for solar heating purposes.

It may be difficult to legislate all of the recommendations presented in this section. The purpose, however, has been to try and develop a comprehensive program which could make the introduction of a solar heating technology as widespread and complete as possible. There may be opposition to certain proposals included in the program as there are those opposed to the various forms of "non-conventional" energy and, in certain cases, their argument may be partially justified due to the uncertainty of the particular energy resource in question. It cannot be denied, however, that there exists a vast amount of unnecessary waste in energy utilization caused, to a certain

degree, by a lack of knowledge in these matters. The program therefore, though primarily intended to promote the use of solar heating, could be justified on the premise that increased public awareness in the area of energy conservation and utilization is a necessity. The argument that such a program would be in the interest of the public welfare is completely valid considering the impact that the widespread use of solar heating would be on releasing fossil fuels for other purposes, such as transportation and fossil fuel dependent industries, and reducing demands on electric utilities.

In addition to promoting the widespread use of solar heating systems, a Solar Heating Program would help the public become well aware of proper methos for conserving energy and ways of exercising energy-conscious habits.

III. SUMMARY AND RECOMMENDATIONS

In this report many recommendations are made, implicitly or explicitly, for definite legislative action which would have an impact on the introduction of solar heating on a significant scale in Ontario, and hence a significant impact on electric loads to be met.

Certain specific recommendations stand out as being important and realizable in the near future, and which immediate action should be considered. These include:

1. Legislative provision for the right-to-sunlight, sufficient to assure a solar heating system owner the continued access to his sunlight so as to insure his investment. The appropriate action would include the legislative recognition necessary to give solar easement agreements legal standing. These would be in writing, and subject to the same conveyance and recording requirements as other easements. The terms of the easement would include: the precise location of the protected area (possibly in terms of horizontal and vertical angles) which define the extent of the solar easement; any terms or conditions under which the easement is granted or can be terminated; or any provisions for compensating the owner of the property subject to the use limitations necessary to maintain the easement.

   Legislation would consider that new developments include provisions for sunlight through the use of restrictive covenants, height restrictions, appropriate setback distances, zoning methods, and other traditional land use controls.

Legislation should facilitate the process of securing solar skyspace easements by creating a simplified system for recording of easements to eliminate the added expense created by involving a lawyer.

Legislation should also require the addition of solar energy impact assessments to the list of factors considered in comprehensive plans submitted by developers to qualify for a building permit.

2. Property assessment relief by removal of the value of solar components from the assessed value of property. Legislation designed to exempt solar heating systems from property taxation should define clearly all equipment unique to the solar installation - these would include solar collectors, thermal storage facilities, heat exchangers, pumps, controls, and other equipment used directly and exclusively for the conversion of solar energy for heating, drying or cooling.

An alternative to making an exemption exclusively for solar systems, a more general approach might be more effective; such as exempting "alternate energy improvements" from property taxation. Such a provision would include not only solar heating, but devices to harness wind power, water power, biomass and other renewable sources.

Legislation should take a clear position on how back-up heating systems for a solar system are to be assessed. Caution should be exercised

against passing legislation that would assess a solar heated building as if equipped with a conventional heating system, or "at no more than" the value of a conventional system. Such legislation could be interpreted as requiring a "double assessment"; that is, the value of the auxiliary system plus the adjusted value of the solar system.

Legislation should also consider the treatment of a property owner's solar rights. In the future, there may be significant value attached to a property with guaranteed access to sunlight. A final matter concerns when the tax exemption should take effect. Property under construction may be taxed, and may not be exempt just because its prospective use would make it exempt.

3. Some form of economic incentive package that would help a solar heating system and purchaser overcome the high first cost of purchasing a solar system. This could be achieved through the tax structure using income tax deductions, income tax credits, investment tax credits, or rapid depreciation. The latter already exists as rapid write-off provision (50% in the first year) for equipment that produces heat from wood waste or municipal waste - such provisions could be extended to include solar heating systems.

   Alternatively, the tax structure could be avoided altogether, and incentives in the form of direct subsidies could be provided as lump sum payments or low cost loans arranged through the banking system for purchasers of solar heating systems.

4. Installations of solar heating systems on new and renovated government and public buildings, where a feasibility study would show that the life-cycle cost of a solar heating system would be competitive with the life-cycle cost of a conventional heating system. The high degree of visibility public buildings have would demonstrate to potential customers, insurance agents and financial institutions the feasibility and economic realities of solar systems. The acquisition of solar equipment should also lower the operating costs of government buildings and help stimulate the solar industry.

5. Encourage the use of life-cycle costing analyses in any feasibility studies for the use of solar heating and its competing alternatives.

6. Review of building codes to include components that are unique to solar heating systems in definitions, where applicable. This would provide guidelines for developers to include solar systems in their design and facilitate their implementation.

7. As an incentive to stimulate utility interest in renewable energy resources, provisions might be made to grant one-half to one percent higher return on investments in projects designed to generate or produce energy from renewable resources. A higher rate of return on capital investments in experimental projects which are designed to improve or perfect technology to generate energy from renewable resources could be included as well. Utilities should be restricted from discriminating against customers with solar-assisted heating systems by charging rates higher than the cost to serve them.

8. Mandating that developers in Ontario carry solar hot water heaters and offer them as an option to conventional water heaters to their customers.

9. Standards requirements for all components that are unique to solar heating systems should be adopted. These would protect consumers from second rate equipment, and the industry from losing credibility as a technically responsible business.

10. A public information program could help the public become aware of conservation concerns, and the realistic capabilities of alternative sources of energy.

11. Mandating that new buildings must make provision for the future installation of domestic solar hot water or space heating through provision of appropriate piping connections and designated spaces convertible to solar collector mounting and thermal storage uses.

IV. ISSUES AFFECTING THE WIDESPREAD USE OF SOLAR HEATING SYSTEMS

1. IMPROVING THE PRIVATE SECTOR ECONOMICS OF SOLAR HEATING SYSTEMS

1.1 Introduction

The most visible disincentive for a potential solar heating system purchaser is the initial high capital cost of a solar installation. This higher cost of a solar heating system has, to a great extent, discouraged its widespread acceptance. As the cost of solar equipment falls, however, and the price of conventional fuels rises, the financial burden associated with the use of solar heating will diminish.

The degree and rate of market penetration for solar heating in Ontario will, in part, be a function of the kind of government incentives made available. Under a low incentive scenario, which assumes the present Ontario sales tax exemption for solar collectors (1), current mortgage rates, and no legislation to protect access to sunlight (2), estimates of the percentage of heating provided by solar means in Ontario have been: (3)

1981	0.04%
1991	0.2%
2001	1.1%
2021	7.3%

Under the high incentive scenarios, which would include the legal right to incident sunlight, low interest loans, property tax exemptions, provincial sales tax exemptions, and standard designs for solar heating systems (4), percentage estimates for heating requirements provided via solar heating are: (5)

1981	0.7%
1991	4.3%
2001	11.5%
2021	33.4%

These figures imply that between 1 percent and 11 percent of the projected heat demand for Ontario could be provided by solar heating in the year 2000, depending on the sort of initiative taken by the government to promote its use.

The benefit derived from using solar heating on a wide scale depends on the economic advantage it may have over other heating systems in the long term, the amount of conventional energy resources that would be conserved and made available for other purposes, the reduction of air and water particulate and thermal pollution, and the reduction in the possibility of fire hazards which are associated with buildings heated by conventional combustion fuels and electricity. (This advantage would apply to completely solar heated buildings, that would not require any back-up heat source. In addition, insurance premiums have been given favourable treatment for these buildings due to the reduced fire hazard.)

The economic feasibility of solar heating is, in part, a function of conventional energy costs (6). Many of the benefits associated with using solar heating apply equally to those derived from widespread implementation of heat conservation measures. As the successful use of solar heating relies on efficient building designs, and proper conservationary techniques, then the legislative incentives considered by the government should encourage both the use of solar heating and heat conservation. Acting in conjunction, both could significantly reduce the demand for conventional heating resources.

The impact on energy savings in Ontario due to government incentives for the adoption of solar heating relative to savings from heat conservation measures have been estimated to be: 68×10^{12} BTU's from solar heating in 2001 and 97×10^{12} BTU's from heat conservation - energy savings through solar heating are estimated to be 40% lower than savings due to conservation (7). By 2021, however, it has been estimated that solar heating in Ontario will account for 245×10^{12} BTU's of savings (or 72 million megawatt hours - equivalent to over 6 times the output from the Pickering reactor in 1975) (8), compared with 105×10^{12} BTU's for heat conservation measures - savings through solar heating might be 2½ times greater than savings due to conservation (9).

Heat conservation would appear to be more immediately effective in reducing the heating demand if implemented on a vast scale, but that is not to suggest that conservation should be the alternative to solar heating. In the long run, both could significantly cut back the need for conventional heating systems.

Currently, the only provincially legislated economic incentive for conservation and solar heating is an exemption from the provincial sales tax for insulating equipment and solar collectors (10). (Included in the legislation are heat pumps and heat recovery units, which might be used to assist solar heating systems, and solar cells for charging batteries, which are not economically competitive at this time.) Other incentives should be legislated to reflect the overall public benefit associated with widespread solar heating, not yet reflected in the private costs of the system. Most economic incentives would be simple for the government to legislate, as many could be built into the existing tax structure (11).

The incentive likely to have the most beneficial impact over the lifetime of a solar heating system is a property tax exemption for all equipment included in the system. Under existing law, the purchase and installation of a solar heating system would constitute a property improvement. Any improvement will generally increase the market value of a property, and thus be assessed and taxed at a higher rate. An annual increase in property taxes may, in fact, negate any of the benefits derived from fuel cost savings. By exempting all solar heating equipment from property taxes, it has been estimated that a lifetime cost savings of 20% can be obtained over an identical system in which the solar heating equipment is included in the assessed value of the property (12).

The exemption of solar heating systems from property assessments is likely to be the most useful legislation in the long term for a solar user.

In order to improve the front end costs, however, other incentives must be legislated. Some of these can be included in the tax structure in the form of tax credits or deductions; and others may be outside the tax system, as guaranteed loans, low cost loans, and direct government subsidies.

There are advantages and disadvantages associated with each incentive. In this section consideration is given to the incentive as it applies to consumers and producers of solar heating equipment.

1.2 Market Incentives for Consumers

i. Direct Grants and Subsidies

A grant or subsidy program would require the participation of both the Federal and Provincial governments. A grant would be awarded to a solar heating system purchaser on a one-time basis to cover some portion of the total system cost, or could be used to subsidize the annual solar system mortgage costs (13).

The grant could cover 25% of the system cost, with a maximum of $1,500 total benefit. This sort of incentive might be awarded over a short period, possibly 3 to 5 years. The idea behind such a program would be to achieve significant market penetration in the early years of solar heating. An alternative incentive would be a declining grant program. In this case, the value of the incentive would be reduced over a period of years, thereby giving the greatest benefit to the first solar installation purchasers. Once solar heating becomes established as a viable alternative to conventional heating systems, the need for incentive barriers is reduced. (14). In addition, a declining grant program will phase itself out naturally, without the need for government termination.

The mortgage rate subsidy program would see the mortgage rates for solar system purchasers drop from the current 10% to a low 8%.

There are a number of benefits associated with all incentive programs, and there are those that are unique to government grants and subsidies.

Grants are probably the most effective way of combating the initial high cost of solar heating systems. Grants and subsidies are awarded outside the tax structure, therefore a qualifying purchaser is reimbursed at the time of purchase of a solar heating system, and does not have to await the end of the tax year to gain the benefit. Grants and subsidies are subject to annual review for budgetary approval, and can therefore be easily terminated by the government after having outlived their usefulness. This makes them more controllable and more visible than tax incentives, and possibly more of an incentive.

ii. Property Tax Exemptions:

There is unanimous agreement that the inclusion of solar heating systems in property assessment is likely to increase the assessed value of a property. From the owner's viewpoint, this is both good and bad. When he seeks to sell, or obtain financing on his property, it is desirable to consider the added value. To include the solar system in yearly property assessments, however, made to determine the amount of tax to be levied on a property, may be unfair. Property taxes incurred by a solar system may, in fact, negate any of the benefits gained by the property owner from reduced fuel consumption. (15)

A property tax exemption for all equipment included in a solar heating system shows a lifetime saving of approximately 20% over an identical system in which the solar equipment is included in the assessed value. (16) From the Berkowitz report, the following tables give an analysis showing how a custom designed solar system compares economically

with a standardized system, and how costs compare when the solar system is included in the assessed value of the property and when the system is exempted from property taxes.

The costs of using standardized designs are approximately 25% less than costs associated with custom design of each solar heating system. It is interesting to note that for the standardized system, whether the solar equipment is included in the assessed value or exempted from property taxes it remains competitive with resistance heating, being approximately 15% and 29% cheaper, respectively. In comparison to oil, however, a standardized solar system will be more expensive by 48% when included in the assessed value and 21% when exempted from property taxation. Taking the most optimistic example from the tables, the breakeven values in Table 2-11, where a standardized system is exempt from property taxes, a price of $.83/gal for oil, or a fuel escalation rate of 9.1% will make solar heating equally competitive with oil based heating systems. In light of recent increases in the price of fuel oils, it may not be long before heating oil reaches a cost of $.83 per gallon, thereby annihilating the economic advantage of using oil. Table 2-11 shows too, that for solar heating to be a viable economic alternative to oil burning systems, a mortgage rate of 7.3% would be required, which could be closely achieved through the implementation of a mortgage rate subsidy program, as proposed in the previous sub-section.

Table 2-8

Custom Designed System Lifetime Cost Comparison:

Solar Equipment Included in Assessed Value

	Solar	vs. Oil[19]	Solar	vs. Electricity[19]
Capital Cost	$9179		$9179	
Annual Mortgage Payment	$987		$987	
Mortgage Rate	10.0%		10.0%	
Initial Annual Fuel Bill		$407		$696
Fuel Price Per Unit		$.69/gal.		$.035/kwh
Fuel Escalation Rate		6.0%		6.0%
Lifetime Costs	$12734	$6600	$12734	$11280
Breakeven Values:				
Capital Cost	$4404		$8045	
Mortgage Payment	$340		$834	
Mortgage Rate	(-)		7.8%	
Solar Panel Costs (per ft^2)	(-)		$5.81	
Solar Storage Cost	(-)		$116	
Solar Misc. Costs	(-)		$168	
Fuel Price Per Unit		$1.33/gal.		$.040/kwh
Fuel Escalation Rate		12.0%		7.4%

Table 2-9

Custom Designed System Lifetime Cost Comparison:

Solar Equipment Exempt From Property Taxes

	Solar	vs. Oil	Solar	vs. Electricity
Capital Cost	$9179		$9179	
Annual Mortgage Payment	$987		$987	
Mortgage Rate	10.0%		10.0%	
Initial Annual Fuel Bill		$407		$696
Fuel Price Per Unit		$.69/gal		$.035/kwh
Fuel Escalation Rate		6.0%		6.0%
Lifetime Costs	$10300	$6600	$10300	$11280
Breakeven Values:				
Capital Cost	$5549		$10136	
Mortgage Payment	$597		$1090	
Mortgage Rate	4.3%		11.4%	
Solar Panel Costs (per ft^2)	$3.17		$8.01	
Solar Storage Cost	(-)		$2207	
Solar Misc. Costs	(-)		$2260	
Fuel Price Per Unit		$1.08/gal		$.032/kwh
Fuel Escalation Rate		10.7%		5.3%

Table 2-10

Standardized System Lifetime Cost Comparison:

Solar Equipment Included in Assessed Value

	Solar	vs. Oil	Solar	vs. Electricity
Capital Cost	$6884		$6884	
Annual Mortgage Payment	$740		$740	
Mortgage Rate	10.0%		10.0%	
Initial Annual Fuel Bill		$407		$696
Fuel Price Per Unit		$.69/gal		$.035/kwh
Fuel Escalation Rate		6.0%		6.0%
Lifetime Costs	$9785	$6600	$9785	$11280
Breakeven Values:				
Capital Cost	$4404		$8045	
Mortgage Payment	$340		$834	
Mortgage Rate	3.3%		12.8%	
Fuel Price Per Unit		$1.03/gal		$.030/kwh
Fuel Escalation Rate		10.0%		4.9%

Table 2-11

Standardized System Lifetime Cost Comparison:

Solar Equipment Exempt From Property Taxes

	Solar	vs. Oil	Solar	vs. Electricity
Capital Cost	$6884		$6884	
Annual Mortgage Payment	$740		$740	
Mortgage Rate	10.0%		10.0%	
Initial Annual Fuel Bill		$407		$696
Fuel Price Per Unit		$.69/gal		$.035/kwh
Fuel Escalation Rate		6.0%		6.0%
Lifetime Costs	$7960	$6600	$7960	$11280
Breakeven Values:				
Capital Cost	$5549		$10136	
Mortgage Payment	$597		$1090	
Mortgage Rate	7.3%		16.1%	
Fuel Price Per Unit		$.83/gal		$.025/kwh
Fuel Escalation Rate		9.1%		.9%

Manitoba has passed legislation exempting solar heating systems from property taxation, and so have many states in the U.S. The Hawaii legislation is particularly effective in that it is non-specific, and therefore includes not only solar heating, but insulation, biomass, wind energy, and other installations. Its contents exempt "alternate energy improvements" from property taxes. These energy improvements on a building would include the use of a process which does not use fossil fuels or nuclear fuels; or maximizes the efficiency of utilizating energy produced by fossil fuels or utilizing secondary forms of energy dependent upon fossil fuels for its generation. (17)

Georgia legislation goes as far as to define a solar heating or cooling system which includes the following components: all controls, tanks, pumps, heat exchangers, and other equipment used directly and exclusively for the conversion of solar energy for heating, drying and cooling. (18)

At present, due to the small number of solar installations available, only the auxiliary system for a solar heating system is taxed in Ontario. (19) This is fair enough considering that back-up heating units place similar demands on ecological and energy resources, albeit the demands are less due to the scale of conventional heating requirements for a solar assisted building. The lack of legislation, however, though less of a barrier than inappropriate legislation, remains a deterrent to the adoption of solar heating, because of the uncertainty it inflicts on potential installation owners. Legislation therefore should give a comprehensive outline of what should be included in an exemption.

Caution must be exercised against passing legislation that would assess a solar heated building as if equipped with a conventional system, or "at no more than" the value of a conventional system. (20) Such legislation could be interpreted as requiring a "double assessment", i.e. the value of the auxiliary system plus the adjusted value of the solar system. (21)

Laws that simply exempt solar heating systems from property taxation should be precise about the treatment of back-up systems. (22) Similar precision should be exercised in statutory definitions of a "solar heating system" to include all components unique to the solar system and to exclude any equipment not directly related, or which is part of the back-up hearing system.

Consideration might be given to exempting from taxation the value of a solar landowner's solar rights. In the future, as skyspace agreements are negotiated and secured, there may be significant value attached to a property with guaranteed access to sunlight. (23)

Another matter concerns when the tax exemption should take effect. Property under construction may be taxed, and may not be exempt just because its prospective use would make it exempt. (24)

In summary, laws that protect a property owner from higher assessments incurred by a solar heating system would be a good incentive, but a well-designed piece of legislation should take clear positions on the following:

a. how back-up systems should be assessed;

b. a complete definition of "solar heating system";

c. inclusion of solar rights in assessment; and

d. whether solar systems under construction are eligible for an exemption. (25)

iii. Income Tax Deductions

Taxation exists primarily as a source of revenue for governments. Under a tax incentive, a taxpayer would be able to retain what would otherwise be taxable income. The intent of such a procedure is to create some public good as a result of the lost public revenue. (26) At present, federal and provincial income tax structures contain types of fiscal incentives which could be readily extended to solar heating systems. (27)

Under an income tax deduction, a taxpayer would be allowed to deduct from his adjusted gross income part of the cost of a solar system, just as for certain medical expenses. (28) This could be a one-time deduction for a taxpayer who would deduct a percentage of the initial costs for purchase and installation of the system.

As an alternative, the government might permit an annual deduction of 25% of the annual solar system mortgage costs. (29)

Income tax deductions may be extended to include maintenance costs of solar installations. Though annual maintenance should be negligible, the

assurance that such costs would qualify as deductions could reduce the hesitancy to adopt solar heating. (30)

Another deduction that might be considered is a depreciation allowance for all solar equipment. Under normal circumstances an individual is not able to deduct from his gross income the allowance for depreciation on his assets - such as exhaustion, wear and tear, and obsolescence of his capital assets. Under certain circumstances, business taxpayers have an option for rapid amortization, or depreciation deductions for certain types of "favoured" property including pollution control facilities. This incentive could be extended to include solar heating equipment. (31)

Whereas normal depreciation is based on the useful lifetime of an asset, under accelerated depreciation or amortization, favoured types of property can be depreciated fully in a much shorter time span, such as five years. (32) Though this kind of incentive is limited to depreciable property, and is usually used by business taxpayers, concessions might be made to include depreciation allowances for private individuals investing in solar heating equipment.

As an example, Arizona has adopted a law that will permit any taxpayer to amortize over a 60-month period, the value of a solar device producing either heat or electricity. This rapid amortization is allowed as a deduction when computing net taxable income for state income tax purposes. The deduction applies to all solar installations for residential, commercial, industrial or governmental uses, or for experimental or demonstration purposes.

The deductible value includes its acquisition and installation costs, of which the latter may include special construction or remodeling costs attributable to the solar device. (33)

The weakness of an income tax deduction approach as an incentive to use solar heating is that, because of graduated income tax rates, the actual tax savings from a deduction is greater, the higher the tax bracket of the taxpayer.

iv. Income Tax Credits:

Using a tax credit approach, the government could permit a taxpayer to reduce his actual tax liability by a certain amount. The advantage of a tax credit is that its value is independent of the income level of the taxpayer.

A tax credit can be granted for the year of purchase of a solar system but, unlike subsidies, tax credits are awarded at the end of the tax year. Provided the recipient of the tax credit receives a tax refund for any excess of the tax credit over what would otherwise be his income tax liability, the income tax credit is essentially the same as a direct grant, except for the timing of receipts.(34)

Legislative proposals from President Carter's Energy package include:

- decreasing tax credit on purchases of "approved" solar heating devices through 1984. The schedule proposed would provide 40% on the first $1,000 and 25% on the next $6,400;

- decreasing tax credits for weatherizing homes of 25% against the first $800 and 15% on the next $6,400; and

- a tax credit of 10% to business conservation investments. (35)

Other incentive recommendations come from the Solar Energy Industries Association - these include:

- taxable rebates which would provide average after tax benefits to the homeowner of 47% of the first $1,000, 40% on the next $2,000, and 33% on the next $3,000 up to 1980. In the following years the percentages would drop to 33%, 27% and 20%;

- additonal taxable rebates providing an average after tax net benefit of 17% against the first $6,000 on a solar system replacing natural gas; and

- business tax credits of 35% on the first $50,000 30% on the next $50,000 and 20% above $100,000 until 1980. Then the percentages on the amounts would drop to 25%, 20% and 15% respectively. Replacement for natural gas would receive an additional 20% on the first $100,000 unti 1980, then 15%. Maximum credit will be 50% of taxable income, with provision for carry-forward as in the present tax credit system. (36)

The State of Kansas provides a tax credit of $1,000 or 25% (whichever is less) of the cost of a solar system against the personal income tax liability of any taxpayer who installs a solar energy system

in his residence. If the tax credit exceeds his income tax liability, the excess may be carried over for deduction in the succeeding taxable year or years but not after the fourth taxable year. It also provides a credit of $3,000 or 25% (whichever is less) of the costs of a solar energy system against the income tax liability of a taxpayer who installs the system on real property used in a trade or business or held for the production of income. (37)

Idaho legislation allows an individual taxpayer an income tax credit of 40% of the cost of an alternative energy device in a taxpayer's residence, and a 20% income tax credit each year thereafter for a period of three succeeding years. A deduction cannot exceed $5,000 in any one year. Cost includes construction, reconstruction, remodeling, installation or acquisition of any "alternative energy device". An alternative energy device means any system or mechanism using solar radiation, wind, geothermal resource, or wood or wood products primarily to provide heating, cooling, electrical power, or any combination thereof - it also includes a fluid-to-air heat pump operating on a fluid reservoir heated by solar radiation or geothermal resources. (38)

As an alternative, a taxpayer could be granted a credit for a certain percentage - possibly 25% of the annual mortgage costs for the solar equipment. Another type of incentive under a tax credit, could be a deduction of maintenance costs from taxes payable. A taxpayer would be reimbursed for all

maintenance costs, thus much of the risk of the system realiability is moved from the owner to the government. (39)

To make applications for tax credits more equitable, taxpayers who installed solar heating systems before the enactment of the suggested legislation should also gain advantages from the statute by allowing the credit to extend to prior expenditures. (40)

Two benefits associated with the income tax credit incentives are:

a) the impact is felt in the early years of the solar system operations, attacking the initial high cost of the system, although not removing it entirely; and

b) income tax credits, as directed from deductions, extend the same savings to taxpayers in different tax brackets.

An income tax credit has the disadvantage of possibly outliving its usefulness, for once changes in the tax code are made, they are generally very difficult to terminate.

v. Investment Tax Credits:

Investment tax credits for business and industry could be allowed in the form of income tax credit to be applied to the purchase and installation of solar heating systems.

vi. Low Cost Loans:

Low cost (interest) loans are essentially subsidies to reduce the interest rate charged on loans to purchase solar heating systems. Favourable rates would show a decrease from the current 10% to a low 8%.

Low interest loans, as for grants and subsidies, may have a more direct impact on the demand for solar heating equipment than tax incentives because they reduce first costs at the time of purchase of the solar system, rather than at the end of the year when tax benefits are received. A low interest loan program would ease financial terms by reducing down payment requirements and lowering monthly mortgage costs. (41) They are generally equitable, providing the greatest benefit to those in the lowest income groups who usually pay the highest price (interest) for borrowed money, and who - because of their low tax bracket - benefit the least in tax savings from income tax deductions.

An alternative approach would be to administer a low-cost loan program through the banks and utilities, as they can both acquire capital at more favourable rates than consumers or manufacturers. However, banks and utilities may require incentives in the form of government guarantees to secure their commitment. (42)

vii. Guaranteed and Insured Loans:

Government guaranteed or insured loans would ease the concern of banks, utilities or other lending institutions which might be concerned about the risk of borrower default on mortgages of solar

equipped homes. Insufficient information about performance and marketability particularly give rise to such doubts. (43)

Loan guarantees under inflationary or economically stable conditions would increase the number of loans that could be made without fear of loss to the lender. Though this may not reduce interest rates, it will reduce the risk and thereby discourage the addition of a risk premium to the price of money. Loan guarantees would probably achieve their maximum effect in conjunction with low interest loans and low cost equipment insurance. (44)

viii. Government Insurance and Reinsurance:

A barrier to the adoption of solar heating is the economic risk and uncertainty associated with a new technology. This may reflect in differential treatment by lending institutions or private insurance companies because of the apparent risks involved. The situation is aggrevated by the lack of actuarial data on solar equipment breakage, durability and maintainability and the effect of special risks such as vandalism and hailstorms.

The fact that a solar heating system adds to the value of a structure may mean that more insurance must be purchased, but this is not a "legal" barrier. (45) If, however, insurance premiums for solar equipped buildings are found to be higher for purely discriminatory reasons, the government may be in the position to intervene. They could directly insure the buildings or reinsure private insurance company policies.

Under certain conditions, buildings are given preferential insurance rates. These are generally extended to buildings that have no combustion furnaces, and derive their heat from district heating. Such preferential treatment has been given to solar heated buildings (46) though no specific category has been designated for solar buildings as of yet. Once standards and requirements have been established, the facilities of policy development should follow.

ix. Government Procurement:

A program wherein the government would install solar equipment on government buildings could encourage the development of a market for solar heating equipment as well as reassure potential customers, insurance agents and financial institutions as to the feasibility of solar systems. The acquisition of the solar equipment should result in reduced operating cost of the government buildings themselves. Many government buildings such as post office and court houses, have a high degree of visibility and the effectiveness of a government procurement program would be magnified in combination with an associated public information Program.(47)

1.3 Market Incentives for Producers

i. Direct Grants and Subsidies

Incentives for manufacturers of solar heating equipment could reduce the initial production costs and, consequently, lower the equipment costs for the consumer.

Subsidies are often proposed to stimulate the the growth of new industries. They may be

directly granted, or used to provide low interest loans. Subsidies are granted outside the tax structure. Whereas tax incentives depend on earned income for their effectiveness, a direct subsidy can be awarded where outright losses may occur. This may be more of an incentive for manufacturers of solar equipment where, initially, there may be little earned income.

Direct subsidies to the solar energy industry could take three basic forms:

a. for laboratory-scale R & D and similar efforts to improve the knowledge base for development of the industry;

b. for construction and operation of demonstration pilot plants; and

c. for the capital and operating costs involved in commercial-scale development.(48)

ii. Low Interest Loans:

If low interest loans are extended to solar equipment manufacturers, the cost of the product may be reduced. This approach would be most favourable during periods of inflation, when capital costs may keep large industries out of marginally profitable areas and small industries and businesses have special difficulties in attracting capital. (49)

The life-cycle costs to the government remain the principle drawback of low interest loans, though these costs may be moderate in the short

run compared to those of direct subsidies and tax credits, which would constitute a direct and unrepaid drain on the treasury. (50)

iii. Accelerated Depreciation:

The Federal Ministry of Industry, Trade and Commerce has allowed a 50% write-off in the first year for equipment that produces heat from wood waste, municipal waste and other methods, if purchased after May 25, 1976 and before 1980. Similar deductions have applied to air pollution equipment if purchased after March 12, 1970 and before 1977. Such preferential treatment could be extended to include solar heating systems, as they are heat producers and should qualify as significant pollution abaters.

Manufacturing equipment used for producing solar hardware could be given accelerated depreciation allowances, especially if certain equipment was subject to rapid obsolescence, such as equipment that might be utilized in automated solar cell production. Firms may also be allowed faster write-off of R & D expenditures.

iv. R & D Incentives:

Given the potential national benefits from greater reliance on solar heating, the Federal and Provincial Governments could encourage and support the advancement of solar energy technology. This could be done through expenditure of funds for solar energy research and development as it has done, for example, extensively for atomic energy.

In addition to providing funds to private industry for solar energy R & D projects, the Government could also give private industry greater incentive to undertake R & D with its own funds. This might be done by granting a certain percentage of research costs as deductible from taxable income, as for mining and drilling exploration by the petroleum companies. (51)

(For State Financial Research and Development of Solar Technologies - see Appendix II.)

v. Government Equity Investment:

Direct government investments covering all or part of facilities and equipment purchased by a manufacturer would be a powerful incentive in that it would help overcome the perceived risks in long-term fixed and specialized asset investment. The government could purchase stock in support of technological R & D in solar technology. (52)

Conclusion

Legislating incentives to stimulate the development of a new industry can be a difficult matter - often there are considerable bureaucractic barriers to overcome. Policitians, initially uncertain of a new technology, may be reluctant to risk public funds in what is, as of yet, an unproven commercial success. The benefits to be gained, however, could be huge, from what has been acclaimed to be "potentially an enormous, ... billion dollar-a-year industry ... in 20 years". (53)

However, the ground work must be done in order to receive the positive qualities of a solar heating industry in the future.

The role of the government should be to remove existing barriers where politically and publicly acceptable, and legislate incentives insofar as it is able, in order to put the solar industry in a favourable position.

Of the incentives available, a property tax exemption for all components of a solar heating system may be the least costly and easiest for the government to legislate, and utlimately provide the greatest benefit for a property owner, as the benefit is drawn throughout the useful lifetime of the installation. Removing the first cost barrier of a solar system, however, will most likely be more complicated and costly for the government to administer. Economic incentives that combat the initial high cost of a solar system, such as direct subsidies, low cost loans, income tax deductions and tax credits, and others, may be initially more attractive, as they are awarded at the time of purchase, or at the end of the tax year, and therefore are more visible and initially more of an incentive to a solar installation purchaser.

The costs to the government will presumably be highest in the early years of an incentive program to stimulate solar heating, assuming higher incentives are given in the early years of the program, and a phase-out period of 3 to 5 years. Though public funds would be used to help finance solar systems, the public would ultimately receive the benefit from pollution abatement, energy resource conservation, and job creation.

At the end of the program, further incentives will most likely not be needed as solar heating should be well established and clearly competitive economically with conventional heating systems.

IV-2. IMPROVING THE FINANCIAL CLIMATE FOR PURCHASING SOLAR HEATING SYSTEMS

2.1 Introduction

There are many factors that affect the economic feasibility of solar heating systems, including the price and availability of competing energy resources, improvements in the design of solar equipment, and the availability of financial assistance.

The terms on which financing is made available could be the single most important factor affecting the acceptability of solar heating systems. Solar systems, like housing, have a high capital cost that must be financed and paid for over time.

The availability of mortgage financing is essential for the vast majority of housing transactions that take place. Few buyers can pay cash, and few will be able to manage the substantial additional costs of solar heating unless these can be financed in whole or in part.

Most families have a relatively limited amount of money available to use as a down payment, and thus the strength of the housing market is affected by how much of the purchase price is covered by mortgage financing. The addition of solar system costs to housing costs especially compounds the problem, unless financing is made available by including the system in the mortgage, or a second mortgage is obtained.

Loan terms (that is, interest rate, length of payment period and amount financed) directly determine the monthly payments that housing owners will make to finance

solar installations. The size of this monthly payment (and the down payment) will significantly affect the economics of solar heating systems from the owner's perspective. (1)

Factors that must be considered by lending institutions include the effects solar heating systems will have on property values, and energy savings. Some lenders believe that the market value of a solar heated building will actually be less than the building cost, and are reluctant to include utility costs in determining the size of the mortgage. (2)

Yet, the cost of amortization of conventional construction cost, and the annual fuel cost for a conventionally heated building may be higher than the amortization costs of a solar equipped building. In this case, financial institutions should formulate mortgage ceilings based on life-cycle costs rather than initial costs. (3)

According to some institutions "conservative investments having a proven market and public acceptance are the major criteria for (institutional) involvement. Cost factors are important, but demonstration projects are a necessity". (4)

The lack of data and information gained from experience with solar heating systems contributes to the difficulty confronting lenders in underwriting applicants for mortgage loans. Until this experience and data base are obtained, applicants will rely on lenders' treatment of such information.

2.2 Lenders Concerns

Of principal concern to lending institutions is the impact solar heating systems will have on:

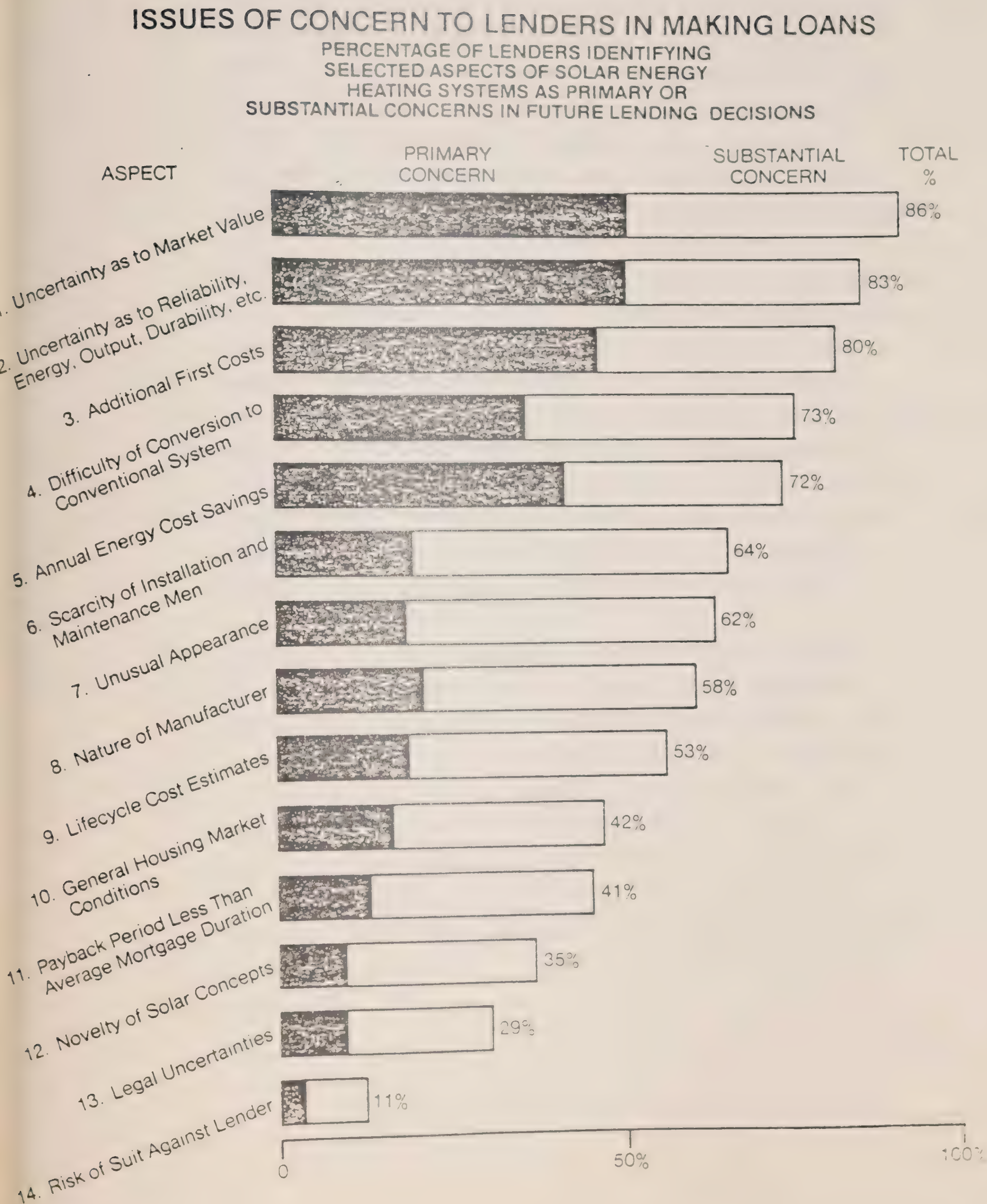
i. property values;
ii. technical performance of the systems; and
iii. estimates of future savings in energy costs.

Figure 2.1 summarizes the concerns of lenders. (5)

i. The Focus on Value

Of principal interest to the lender is the manner in which a solar heating system affects the value of a property and the ease with which it can be disposed of under foreclosure conditions. The controlling factors here are that mortgage loans are made in relation to the value of the property offered as collateral, rather than its costs, and that there is presently considerable uncertainty with regard to the value a solar heating system may add to the property. (6)

FIGURE 2.1


ISSUES OF CONCERN TO LENDERS IN MAKING LOANS
PERCENTAGE OF LENDERS IDENTIFYING SELECTED ASPECTS OF SOLAR ENERGY HEATING SYSTEMS AS PRIMARY OR SUBSTANTIAL CONCERNS IN FUTURE LENDING DECISIONS
ASPECT
PRIMARY CONCERN
SUBSTANTIAL CONCERN
TOTAL %
Uncertainty as to Market Value
86%
2. Uncertainty as to Reliability, Energy, Output, Durability, etc.
83%
3. Additional First Costs
80%
4. Difficulty of Conversion to Conventional System
73%
5. Annual Energy Cost Savings
72%
6. Scarcity of Installation and Maintenance Men
64%
7. Unusual Appearance
62%
8. Nature of Manufacturer
58%
9. Lifecycle Cost Estimates
53%
10. General Housing Market Conditions
42%
11. Payback Period Less Than Average Mortgage Duration
41%
12. Novelty of Solar Concepts
35%
13. Legal Uncertainties
29%
14. Risk of Suit Against Lender
11%
0
50%

"Over time of course, the market place will serve as the definitive arbiter of value, with the knowns, unknowns, virtues and liabilities of solar systems reflected in the price consumers are willing to pay for new and used homes that incorporate solar energy devices" (7) However, with a very short solar financing record, lenders will have to proceed in the absence of any significant volume of experience in the sale of "comparable" properties.

What will necessarily be considered is the possibility that the market value of a solar installation may be less than the costs associated with it, and that loans offered will therefore be a proportionally smaller part of the additional sales price. In other words, the installation of solar equipment may be classified as an "overimprovement" to the property. Under these circumstances lenders may exclude the cost of a solar system from property valuation in determining the maximum amount they will lend.

Although lenders emphasize that it is the market that will determine the value of solar systems, their judgement will be what sets the market value until there is the "body of evidence" to establish a true market value. Lenders have observed that when solar systems are demonstrably reliable and economically desirable for a purchaser, the impact on value may be felt not only as a rise in the value of buildings that have such systems, but also as a fall in value of conventional buildings that lack them. (8)

ii. Technical Performance

"Financial institutions generally lack the motivation, and in many instances the skills, to examine the technical details of construction - including basic mechanical systems - with the same care they devote to assessing the marketability, value and overall reliability of (properties) proposed for mortgage financing". (9) Where special needs arise, a detailed engineering review will be undertaken using an outside consultant if necessary.

When lenders receive their first loan requests on solar heated buildings, however, they are confronted by a situation where uncertainties regarding the mechanical reliability of the heating system itself do, in fact, have a direct bearing on the value of property as security for the mortgage. In many cases before a lender will consider financing a significant part of this solar first cost as part of the total mortgage, a thorough engineering appraisal of the system proposed may be required - usually at the borrower's expense. Where a lender can't make such an evaluation, or sees it as too much trouble to obtain for a single loan request, he may be even more conservative in respect to the terms on which financing will be provided, if it is provided at all. (10)

One possible solution to the concern over performance failures by solar installations, is the provision of warranties by solar manufacturers, installers or builders. However, from interviews with many lenders across the U.S. carried out by Regional and Urban Planning Implementation Inc. (RUPI) (Cambridge, Mass.) few attached great importance to the availability

of a warranty for solar products. Most agreed that a large, nationally recognized manufacturer, one that was certain to remain in business over the lifetime of the system, would facilitate the acceptability of solar products. Only a few lenders felt that the production of systems by a well known supplier might be an absolute prerequisite for their making financing available. A fourth of those interviewed expressed "little" or "no" concern with the manufacturer's identity. The diversity of attitudes obtained from many lenders suggestes that a refusal by any one lender should not deter a solar system purchaser from continuing to seek a lender who will make a loan. (11)

iii. Estimating Energy Savings

The expectation of savings in operating costs from solar heating systems is the very aspect that holds the promise for their widespread adoption. At least in the outset, there are likely to be many problems raised by lenders' treatment of these projections in the evaluation of multi-family rental properties, and their use for determining the value of single-family installations and underwriting applicants for home mortgages.

In most instances, lenders employ the "economic" or "income" valuation approach to assessing mortgage loan requests for income-producing properties such as rental housing developments. No matter what precise valuation technique is employed the impact of solar heating on the attractiveness of a project for solar financing will be reflected in a straight forward manner, since the estimated solar costs

and savings enter directly into the net cash flow equation (income less operating costs and mortgage debt service).

As part of his loan application, a developer will submit a form itemizing the major constituents of gross income and expenses. A large part of the first costs of a solar installation will be reflected in the line item for annual debt service (amortization of loan principal plus interest). (12) Other contributions to total expenses - particularly the allocation for repairs and maintenance, utility costs, real estate taxes, insurance, and any reserves for replacement or other contingencies - might be affected to some extent by the inclusion of solar heating. Once considerable information and data has been obtained from various solar financing projects, these estimates may prove relatively easy to verify based on actual operating experience with specific systems. However, at the present time it would be difficult for lenders to devise a credible financial projection for a solar heated development. Since the economic feasibility is based entirely on cash flow, the income stream would have to be determined "within reasonable probability". Otherwise the cash flow projections would have to be discounted heavily in the appraisal process - or the project rejected altogether. (13)

For valuation purposes, net operating income under both solar and conventional alternatives would be examined solely on the basis of current utility prices, with no allowance for fuel price inflation over time. This is consistent with the general practice for quantifying other components of cash

flow which may vary unpredictably from year to year (but always increasing), such as real estate taxes, wages for security and maintenance personnel and the basic rent schedule for the units themselves. (14)

In single-family housing, energy cost savings are not reflected in property valuations. In appraising the value of such housing, lenders normally consider information on the sale of "comparable homes". However, in the case of solar homes, this information will be lacking for a number of years and lenders will be reluctant to use "replacement costs" (that is, the price of the solar installation) as an alternative indicator of value.

Solar first costs can be determined with some reliability, but in reviewing estimates of fuel savings with solar heating, the lender must contend with the claims of manufacturers and developers he suspects may be inflated and self-serving, or else obtain information from more disinterested experts. Lenders will tend to discount the estimates to some degree, and to resist the use of project increases in alternative fuel costs. (15)

"The approach to valuation will vary considerably, from payback period and lifecycle cost analyses to the capitalizing of estimated savings and discounted cash flow approximations of present value." (16) From the same survey of lending institutions, however, these analyses were not viewed as criteria to determine whether or not to grant a loan, but rather as partial guidelines in value appraisals.

The manner in which solar costs and savings affect the value of a property will be of primary concern to lenders. However, there is another problem concerned with the way in which lenders evaluate a homeowner's capacity to pay off a mortgage loan.

Most lenders use a comparison of projected housing costs to a loan applicant's income as a guide to determine the maximum size loan for which he may qualify. Generally housing costs should not exceed 25% of an applicant's income. The bias against solar heated homes emerges when housing costs are evaluated, because lenders do not consider energy costs in their calculations, or that any decrease in conventional fuel costs provides more available income to help amortize a mortgage loan.

In most cases, housing costs are determined by <u>principal</u> and <u>interest</u> payments on the loan, property <u>taxes</u>, and frequently, hazard <u>insurance</u> premiums - often referred to by the acronym "PITI".

The resulting problem for solar heated homeowners is that savings in utility bills have no bearing on the financial capacity as evaluated by the lender. At the same time, the higher first costs of the property, as reflected in a higher mortgage request (and higher principal and interest payments), and higher insurance premiums and property taxes (the latter may not apply if solar heating systems become exempted from property taxation), do raise the income requirement as established by the PITI test.

It has been suggested that utility costs be added to calculations of housing costs. The suggestion, however, is a double-edged sword: although solar homes would look better in comparison, fewer applicants would qualify for home loans at a time when a high percentage of Canadians is already priced out of the home market. (17) Nevertheless, all lenders in the RUPI survey said that energy costs will become increasingly important to their lenders' decisions, and RUPI recommends the consideration of home energy costs in lender underwriting procedures. They found that excluding energy costs when figuring an applicant's ability to pay "may be an important constraint on the availability of financing for solar homes". (18) The American Bar Foundation have suggested a statute requiring lenders to consider fuel and equipment costs in all their financial decisions (19), but it is likely that financiers will begin to take such steps without legal measures, because it will be in their obvious self-interest to do so.

A factor that lenders should consider is that although solar buildings are more expensive, their owners can capitalize part of their heating costs rather than face steadily increasing monthly energy bills.

2.3 The Importance of Life-Cycle Costing

In order to fully appreciate the benefits of a solar heated building, consumers and lenders must understand and use life-cycle costing analyses for solar heating systems and their competing alternatives. As the solar alternative has a high initial cost and relatively low

operating cost, its financial advantages over a conventional heating system are apparent only over a period of use.

Life-cycle costing estimates the net costs of a solar heating system over its useful life. It includes acquisition costs, savings, operating costs (if any), maintenance costs, and salvage value. (20)

The Government of Ontario should require that life-cycle costing analyses be carried out on all new and renovated government buildings to determine and minimize energy costs to service such buildings, and where the solar alternative is marginally, or clearly, worthwhile the Government should encourage its use.

The RUPI study has found that a sizeable percentage of lenders surveyed were concerned with information on both payback periods and life-cycle costs (where "pay-back periods" are the time needed to completely return an initial investment; that is, in the form of net savings in heating costs).(21) Lenders consider other costs as well (see previous subsections), and would not make or refuse a loan on the basis of life-cycle costs or payback period. The RUPI study also discovered that many lenders were unfamiliar with the concepts of life-cycle costing, and that few regarded it as a more useful tool than the more immediate payback period or capitalized value. (22)

There are certain difficulties associated with the use of life-cycle costing, in that Canadians move frequently. The implications of this transiency are that some lenders do not believe that solar systems will be widely accepted until payback periods are shorter than a mortgage's life.

Another difficulty with life-cycle costing is the unpredictability of future events that have a direct bearing on solar systems. For instance, costs of fuel in 20 years time, types of incentives the Government might legislate, durability of various types of solar systems, and discovery of completely new energy systems will all impact on the future costs of solar heating systems, and on competing systems.

There is little doubt, however, that the price for energy will ever come down to the prices that encouraged the development of buildings, and other energy dependent systems, along the lines we have grown accustomed to. Energy considerations have already become important factors in determining the feasibility of planned development projects (the existence of the RCEPP bears testimony to this fact), and it would make sense that lending institutions include such criteria in their lending equations.

2.4 Financing Solar Retrofits

In reviewing requests for home improvement loans, which would include solar retrofitting, lenders generally consider a borrower's credit worthiness and are relatively disinterested in the value of the property as collateral for the loan. Thus financing solar retrofits should be possible on normal terms from traditional sources. (23)

In credit evaluations, a lender will seek to judge both the applicant's ability and willingness to repay, based on his income, job security, outstanding indebtedness, credit record, and other factors.

Home improvement financing generally involves significantly higher interest rates than mortgages, consequently, a property owner would prefer to secure a long-term second mortgage at an interest rate slightly higher than that of the first mortgage.

Since the costs of solar heating are principally capital costs, as opposed to fuel costs, solar financing is extremely sensitive to interest rates, and its feasibility may, indeed, hinge on them. (24) "In other words" according to one study "if either the cost of capital or the rate of interest doubles, the cost of solar energy nearly doubles". (25)

If denied a second mortgage, and retrofitting is more expensive than would be justified under a home improvement loan with a high interest rate, property owners have the option to refinance the entire property. Lending institutions are generally willing to do this since real property is appreciating so rapidly and interest rates have risen of late. Lenders will be agreeable so long as:

a) a property owner has already built up sufficient equity in the property (through mortgage payments and increases in the property's market price) so that the lender is in effect assuming no extra risk of loss by including the solar system in mortgageable value; and

b) the borrower agrees to refinancing the mortgage at a higher interest rate. (26)

Since most buildings were built and financed at lower interest rates than those prevailing today, most lenders would welcome the opportunity to adjust the rate upward. The property owner will have established his credit-worthiness from payments on his first mortgage which will facilitate the transaction from the lenders perspective.

When compared with a conventional home improvement loan, the attractiveness of refinancing mortgage depends on:

a) the comparative interest rates and terms of the two types of financing;

b) the amount of the outstanding balance and number of years remaining on original mortgage; and

c) the cost of the retrofit installation itself. (27)

Refinancing techniques provide complete financing for solar retrofits, but do not overcome the problem of high interest rates. An alternative which has been used in California and other western states is a mortgage containing an "open-ended" clause that allows a homeowner who has built up equity to borrow back up to the amount of the original loan at the original terms. (28)

Another alternative financing method called a "wrap-around mortgage" may benefit some homeowners. A new loan is "wrapped around" an existing mortgage which is preserved, and the new mortgage is for an amount equal to the outstanding balance of the first mortgage plus any additional funds loaned. Its interest rate is always higher than the first mortgage, but equal to, or somewhat lower than the current market rates on equivalent properties. A wrap-around mortgage may not be as attractive to a borrower as an open-ended clause, but in a time of rising interest rates it may be cheaper than refinancing or than a second mortgage. (29)

2.5 Government Financing

The limited availability of financing may impose a "constraint" on the size of the residential solar heating system market, or on the rate at which sales to that market will grow. It is generally recognized that the size of the market for housing at any given cost bears an inverse relationship to the amount of down payment required. Thus the terms under which financing is now available for residential housing is likely to be a constraint, limiting the market to a smaller proportion of buyers who are able to put up a larger proportion of the additional first costs involved in purchasing a solar system. (30)

Guaranteed financing for solar heating systems may be one of the most powerful incentives the government could legislate. It would provide a borrower with "full" financing of a solar system cost - a good loan-to-value ratio, and a full inclusion of solar system costs in appraisals. A guaranteed, full financing program would remove the burden of down payment costs from certain

purchasers. Applicants could qualify by submitting a copy of their tax return. Those in lower tax brackets would be granted full financing, applicants in higher tax brackets would be required to pay the down payment. All financing would be carried out through the banking system, except for guarantees by the government, in order to remove the risk of failure of a solar system from lending institutions.

Alternatively, the government could undertake the financing itself, and loan homebuyers sufficient to cover the cost of a solar system. The loan could be at a rate lower than prevailing bank rates, as the government can borrow at a lower interest rate than banks can. Such a program, either alone or in conjunction with other economic incentives could encourage an early adoption of solar heating by reducing monthly mortgage payments. (31)

2.6 How Financing Affects the Costs of Solar Heating

Table 2.1 illustrates the differences among the size of the down payment and monthly loan payments for an $8,000 solar system financed under different loan types prevalent in single-family home financing. The figures are from the RUPI study (32), and do not necessarily reflect the current rates available in Ontario, but serve to show the effect on monthly payments, and therefore, on the amount of monthly energy cost savings needed to make such a system "pay for itself" on a current basis.

Table 2.1

HOW FINANCING AFFECTS SOLAR COSTS

Illustrative Loan Terms and Monthly Debt Service Under Private Lender Financing Alternatives

	First Mortgage					Second Mortgage	Home Improvement	
Loan/Value Ratio	70%	80%	90%	93%	100%	75%	100%	100%
Interest Rate	8.5%	8.75%	9.0%	8.25%	9.0%	13.5%	11.5%	12.5%
Maturity (years)	27	27	27	30	30	10	12	5
Mortgage Insurance	-	15%	25%	15%	-	-	5%	-
	$	$	$	$	$	$	$	$
Monthly Cost per $1,000 of Loan	7.88	8.16	8.41	8.06	8.23	15.23	13.13	22.50
Down payment for an $8,000 Solar Heating System	2,400	1,600	800	560	-	2,000	-	-
Monthly Cost for an $8,000 Solar Heating System	44.15	52.23	60.53	58.53	64.37	91.36	105.07	179.98

For example, a first mortgage for 70% of the total system cost of $8,000 would provide $5,600 toward the cost of the system, at an interest rate of 8.5% to be paid over 27 years. The purchaser would need to make a $2,400 down payment, and then making monthly payments for principal and interest on the loan of $44,15 for the remaining 27 years. If a loan was obtainable for 93% of the system cost, the down payment would be reduced to $560, and the monthly payments would be $58.53 for the 30 year term of the loan. On the other

hand, if the system could only be financed through a short-term home improvement loan, the full cost might be borrowed, eliminating the down payment entirely, but increasing the monthly payment to $179.98 for the 5-year term of the loan. Thus the financing terms have a direct and critical effect on the costs of a solar system, and the feasibility for a purchaser to obtain one. (33)

In Table 2.2, the solar system has been included in the appraisal value of the property. Again, the figures have been obtained from the RUPI study and are not representative of Ontario's current rates.

Table 2.2

Impact of Below Cost Appraisal and Lower Loan-to-Value Ratios on Down Payment for New Home With an $8,000 SOLAR HEATING SYSTEM

	% of Solar Cost in Appraisal Value	0.70 Loan-to-Value Ratio	0.80	0.93
Net Addition to Down Payment for Solar Use	100%	$2,400	$1,600	$ 560
	75%	3,800	3,200	2,420
	50%	5,200	4,800	4,280
	25%	6,600	6,400	6,140
	0%	8,000	8,000	8,000

As shown in Table 2.2, if a borrower received 80% financing and if 100% of the solar first cost were included in the home's appraised value, his decision to install solar equipment would add only $1,600 to his

initial down payment. However, if the lender were to exclude 50% of the solar cost in his appraisal and is willing to make only 70% financing available, the borrower must provide an additional $5,200 in cash. Even under high ratio financing, conservative appraisals may impose substantial down payments on purchasers of new solar homes. (34)

2.7 Guidelines for Government Action and Conclusion

A Government incentive program, insofar as it is directed to the lending community, should consider the following:

"i. The need for a program that is workable in operation, responsive to the needs of lenders for rapid and definitive decisions, and sensitive to the disinclination of many lenders to participate in (Government) insurance programs;

ii. The need to protect homebuyers of moderate means from assuming undue financial risks. (The constraint attributable to smaller than normal amounts of financing is perhaps better addressed through direct consumer subsidies than by inducing lenders to offer mortgage loans that may in fact exceed actual market values.);

iii. The incentives and subsidies that may be provided to builders and buyers of solar homes under other programs, and the initiatives of other energy conservation programs that are directed at lenders; and

iv. The particular need for market support in the short term." (35)

A consideration that must be taken into account in any incentive package is that due to the nature of the financing constraint, subsidies designed for reducing the down payment requirements may have more impact than those aimed at reducing monthly costs. Whether directed at lenders or borrowers, both must be made aware of this.

In respect to specific actions for lenders, the availability and terms of financing for solar homes might be improved by the following:

"i. A research and action program designed to encourage the inclusion of home energy costs in lender underwiting procedures;

ii. Procedures for system certification that will help lenders assess the economic and technical performance characteristics of available systems;

iii. A special insurance program that insures lenders for the costs of repairing or replacing the solar energy system or converting to a conventional heating system if necessary to allow recapture of investment at a foreclosure sale; or a program that insures lenders against the "top part of the risk" on loans for solar homes; and

iv. Intiatives to facilitate the acceptance of solar homes in all (Government) loan programs and in the activities of the major secondary mortgage entities, along with an active program of information outreach to target lender groups." (36)

IV-3. THE INTERFACE BETWEEN SOLAR HEATING SYSTEMS AND PUBLIC UTILITIES

3.1 Introduction

The deployment of solar heating systems on a large scale could significantly impact local utilities and consumer/utility relations. The precise impacts will depend to a large extent on the number of solar systems in use, their size and efficiency, their function (solar space heating and/or water heating), and ultimately on the type of auxiliary capability they employ (whether on site combustion materials or utility supplied gas or electricity).

There is no doubt that solar heating will reduce the demand for conventional heating resources. However, for solar assisted buildings that depend to varying degrees on utility back-up, there is concern about the timing of utility assistance. The demands on these auxiliary systems will tend to increase during periods of extreme cold and extended cloudiness. Such periods will occur at about the same time for all solar heating system owners in a utility's market area, at a time when the utility may already be experiencing its peak demand. Though off-peak demand for energy will decrease, the utility may still have to maintain a high generating capacity for the peak period demand. The impact of the deployment of solar heating systems will, thus, be determined by the relationship between the total reduction in utility supplied energy demand and the reduction in demand during the utility's peak hours.

A utility's capital costs are determined by the magnitude of the peak demand experienced and the load factor. The load factor, the ratio of the average load

to the peak load, determines how efficiently capital resources are being employed. A high load factor means that more efficient generation facilities are used a greater precentage of the time. This results in lower generation costs for the utility and lower rates for the consumer except in special circumstances.

To compute the true cost of supplying auxiliary energy to solar buildings, the effect of auxiliary use on both coincident peak and load factor must first be determined, along with the associated costs of these effects. The true costs include the additional capacity required to supply the demand, and the fuel costs of generating that demand. The average cost rate of electric and gas utilities (i.e. total costs/total demand, expressed in $/kwh) does not adequately reflect the overall costs of power generation. The differential in peak and off-peak costs should be reflected in utility prices by implementing peak load pricing policies. These marginal cost rates are desirable because they encourage customer participation in reducing peak power demands and therefore lowering energy costs, they help control utility load factors, and conserve energy. In addition, they are more equitable since charges to consumers reflect the actual costs of power production.(1)

Apart from pricing incentives, other load management techniques that would help mitigate the solar/utility interface would include direct and indirect control of customer consumption patterns, telemetry and decentralized thermal heat storage techniques using off-peak power. This section will also consider the possibility of utility owned, installed and leased solar heating systems, and an analysis of options within the solar/utility interface.

3.2 Solar/Utility Interface Studies

A number of problem areas in the solar/utility interface have been identified by the National Science Foundation of the United States and have been given priorities for research. These include:

i. the impact of public utility rate structures on the market penetration of solar energy;

ii. the impact of solar energy space conditioning and water heating on competing and complementary industries; and

iii. the supply, ownership, and/or manufacture of solar energy equipment by public utilities. (2)

Table III-1 summarizes the participants, the nature of the work, and the area of interface consideration.

3.3 The Impact of Seasonal Heat Storage Systems

Solar heating systems are usually provided with auxiliary heating systems which in many cases would use public utility power sources.

From the public utility point of view there is a major distinction to be made between the loads which would be generated by solar space heating systems having short term (2 to 5 day) heat storage capacity, and by systems with the capacity to store heat from season to season. In the case of short term storage space heating systems, it is usually uneconomic to design for more than about 60% of the annual heat load to be carried by the solar source, and, because of the occurrence of successive days of cloudy weather in winter, impossible to supply more than about 85% of the total heat required.

In a given community with a significant number of short term storage solar heating systems all of these systems would more or less simultaneously require auxiliary energy since all would experience the same weather pattern. This would most often occur in the December and January periods and could coincide with the normal peak demands on the public utility. It would therefore be a highly undesirable load, with a low load factor and an unfortunate timing. It could be, to some extent, ameliorated by the use of overnight or weekend surplus capacity to heat the storage, but it could not avoid raising the monthly demands in December and January.

Annual storage systems have a quite different characteristic. Because they have a large storage capacity, sufficient to carry heat over from summer to winter, they are insensitive

to long periods of cloudy weather and can be economically designed to provide 100% of the heat required in an average year from the solar source. They normally would be supplied with an auxiliary back-up system to insure against break-downs and to provide for initial system start-up. These auxiliary systems would be used only at random times, and in total very little, so they would not generally speaking add to the peak demand of the public utility system.

Moreover, with the annual storage system, any shortfall in capacity occurring in a particularly unfavourable year would represent only a small percentage shortfall from the full heating capacity load, and a relatively small make-up load, whereas short term storage systems can be completely depleted and all of the heat load would fall on the auxiliary source.

From the public utility point of view, therefore, it would seem rational that they encourage the development of annual storage solar space heating systems which will relieve them of heating demands without imposing increased peak capacity requirements. Close examination of this public utility interface could lead to pricing or other policies designed to encourage use of those systems compatible with the public utility interests and to discourage those which in effect simply shift the burden of stand-by from the private owner to public system.

3.4 Load Management Possibilities

Electricity for residential space heating purposes has increased in Ontario from approximately 1% in 1960, to about 25% in 1975. (2) With a shift to space heating demands being supplied by resistance heating, consumption concentration occurs in the winter heating season. If not managed, this shift may lead to an increasing seasonality and temperature sensitivity of Ontario Hydro's total demand. This may be further complicated by electrically assisted solar heated structures that would encourage the seasonal demand.

Preventative actions by Ontario Hydro should be taken to mould customer behaviour to a desired pattern. The objective would be to shift demands, where possible, from peak hours to off-peak hours. There are a number of methods that have been employed elsewhere, and have shown various degrees of success. Of them, pricing incentives, telemetry and decentralized thermal storage will be considered.

i. Utility Pricing

Under utility pricing schemes, utilities may choose indirect control, or direct control to change consumption patterns.

Indirect Control would utilize rate incentives and public education to shift consumer demand away from system peaks. This gives the individual customer control over the extent to which his load at system peak is reduced.

Direct Control offers interruptible service at reduced rates to customers with space and water heaters equipped with time or radio controlled switches. Heat storage systems could be integrated with appliance control in the building by the utility.

The concern of solar users with regard to utility pricing can be illustrated in the following example. A building owner considering a solar system is told he can expect to reduce his annual energy consumption by 70%. The owner purchases the system and it performs as promised. However, he finds that his utility bills have dropped by far less than expected, and his total dollar savings amount to only 50%. The difference is attributable to a declining block rate schedule, which imposes a higher fee for the first block purchased. This pricing system is the most common rate structure for residential customers, and was designed to encourage long-run growth in demand. (3)

The treatment of utility pricing in light of solar adoption must consider the following:

a. utility costs and the efficiency of current rate schemes for recovering these costs;

b. the relative impact of utility rate schedules upon solar space conditioning and conventional system customers. (4)

Utility cost of generating electricity consist of capacity costs (generation, transmission and distribution costs), energy costs including fuel prices, and customer costs including metering and hook-up. There are two widely used rate schedules or tariffs for recovering these costs: the declining block rate (or average cost rate schedule) and the energy/demand rate. Under both schedules the price

of electricity depends on who the customer is and how much he consumes. Within classes of consumers, rates are usually a decreasing step function of the quantity of power consumed.

A typical declining block rate for Rockwood, Ontario is shown in Table 3.1 (5)

TABLE 3.1

TYPICAL RESIDENTIAL RATE SCHEDULE

First 50 kwh	7.40¢ per kwh
Next 200 kwh	3.70¢ per kwh
Next 500 kwh	2.20¢ per kwh
Balance block	2.40¢ per kwh

The logic of this type of schedule lies in the fact that distribution and transmission costs lead to high fixed costs of energy production, supposedly resulting in lower than average costs for additional increments of consumption.

Lowered average costs of additional consumption also result from alleged economic of scale associated with generation. Generation costs, however, vary as demand varies. An average cost rate (total cost/total demand, expressed in $/kwh is inadequate in computing overall costs of electric generation. (6)

Table 3.2 shows a typical energy/demand tariff for general service in Rockwood, Ontario. (7) This schedule divides the final price for that power into two components, energy and demand (in kilowatt hours) and demand (in kilowatts),in this case the

energy charge is a decreasing step function of the amount of power consumed. The demand component results from the inability to store electric power. Accordingly generating facilities are designed to provide sufficient kilowatt capacity to meet peak demands. The cost of this capacity is reflected, albeit crudely, in the demand component.

TABLE 3.2

TYPICAL GENERAL SERVICE RATE SCHEDULE

ENERGY CHARGE	
First 50 kwh	7.40¢ per kwh
Next 200 kwh	4.00¢ per kwh
Next 9750 kwh	2.75¢ per kwh
Balance block	1.65¢ per kwh
DEMAND CHARGE	
First 50 kwh	No charge
Balance block	$2.20 per kwh

For industrial users, energy charges are fixed at 0.925 cents per kilowatt hour and demand charges vary between the various "classes" of customers. Those include customers that utilize firm supply of electricity and customers that agree to interruptible power supply. The latter are classified "A" and "B", where class "A" may be interrupted between Monday and Friday, and class "B" may be interrupted daily. For industrial customers a typical rate schedule is shown in Table 3.3. (8)

TABLE 3.3

INDUSTRIAL RATE SCHEDULE

ENERGY CHARGE

Fixed at 0.925¢ per kwh.

DEMAND CHARGE

	Firm $/kwh	Class "A" $/kwh	Class "B" $/kwh
230,000 Volts	3.94	3.15	2.75
115,000 Volts	4.07	3.28	2.88
Sub-Transmission Voltage	4.28	3.49	3.09
Primary Distribution Voltage	4.46	3.67	3.27

For firm power supplied, the cost per kilowatt per year and cost per kilowatt-hour at various load factors is shown in Table 3.4 (9)

TABLE 3.4

OST PER KILOWATT PER YEAR AND COST PER KILOWATT-HOUR AT VARIOUS LOAD FACTORS

		LOAD FACTOR PER CENT							
		30	40	50	60	70	80	90	100
30 kV	$/kW	71.59	79.69	87.80	95.90	104.00	112.10	120.21	128.31
	¢/kWh	2.72	2.27	2.00	1.82	1.70	1.60	1.52	1.46
15 kV	$/kW	73.15	81.25	89.36	97.46	105.56	113.66	121.77	129.87
	¢/kWh	2.78	2.32	2.04	1.85	1.72	1.62	1.54	1.48
ub-ransmission	$/kW	75.67	83.77	91.88	99.98	108.08	116.18	124.29	132.39
	¢/kWh	2.88	2.39	2.10	1.90	1.76	1.66	1.52	1.51

With prices of power being a decreasing step function of the amount of power consumed, for any two customers subject to this schedule (assuming equal energy consumption) the final bill is based on their respective "load factors", the ratio of their average consumption during a specified period to a peak consumption during the same period. This "load factor" is inversely correlated with the average price of power. That is, the schedule penalizes erratic loads and rewards even loads: a reflection of the capacity requirements. This tariff does encourage each customer to distribute his demands on kilowatt capacity more evenly on a decimal base. The entire utility system, however, may not benefit from such a tariff, since individual customer peaks may not coincide with system peaks. Cost minimization for utilities requires an even distribution of demand for the system as a whole. (10)

Under average cost rates, the costs of production to the utility are distributed over the total number of kilowatt hours generated. The solar building that places greater demands on utility peak hours, as a result, is being subsidized by other electric consumers under average cost rates. This might be justified considering that a reduction in electricity requirements results in a reduction in the marginal cost of fuel used for electric generation. This cost reduction is beneficial to all utility customers and could justify charging a solar heating customer a rate which does not fully equal the cost to serve him.

The effect of the energy/demand tariff upon consumers is complex. The impact on solar users is likely to be negative since the occasional user would pay a relatively high rate for any occasional demand, despite very low amounts of total energy consumption. The issue is no longer "will the solar energy consumer require supplemental power during system peaking conditions?" but, since the energy/demand tariff is tied to the individual's peak, regardless of whether it coincides with the system peak, the relevant argument is whether the solar user is being unduly penalized. Whereas the solar heating system is propitious to the user under residential tariffs, the converse may be true under the energy/demand tariff. Since the economics of solar heating are presently marginal in most places, the use of energy/demand rates for solar users could be a significant setback for solar system users and the entire solar heating industry.

Marginal cost pricing is an alternative rate structure that would take into account the fact that generation costs vary as demand varies. Assuming a differential in cost for various additional units of electricity, the concept of marginal cost pricing involves charging a consumer a price equal to the incremental capacity, energy and customer costs associated with that particular unit of electricity. High voltage is cheaper to produce than low voltage; base load generation is more efficient and thus cheaper than the use of peaking plants. A marginal cost pricing scheme takes into account these margins of electrical supply when used in s pricing schedule. (11)

Interruptible rates for both solar and conventional system consumers would have potentially positive impacts on affecting utility loads. Because the demands for peak capacity are so infrequent in some solar buildings, it may be most efficient to offer a reduced rate to those users who occasionally forego peak use. This rate incentive would be particularly useful for buildings with some heat storage capacity, as this would encourage the storage of off-peak power for use when the utility is experiencing its peak demands.

ii. Telemetry

To assist utilities in their total load management programs, there are two primary mechanisms available; they are the application of power line carrier techniques for the control of consumer electrical appliances and the application of both metering and power line carrier techniques for more efficient tariffs.

The principal power line carrier technique is ripple control. Its applications are:

a. leveling of peaks and valleys, thus improving the load factor;

b. consumer level load of: water heaters, space heaters, control air conditioning systems, water pumps (irrigation and swimming pools), high-load tariff switching kwh meters;

c. auxiliary functions of resetting maximum demand meters, systems control, street and other lighting;

d. industrial use implications of heating and cooling, freezing, and electrically driven mechanical devices. (12)

To justify the application of such load management techniques, a comparison can be made of the investment required to install a ripple control system with the resultant savings. Investment per kilowatt for generation, transmission and distribution systems by hydro, coal or nuclear systems total $350 - $800 per kilowatt. (13) Ripple control systems cost approximately $120 per controlled customer. (14) The potential exists to save several kilowatt per controlled customer.

Remote metering and load management offer high reliability and accuracy and low installation and operating costs. Residential automation is achieved by load shedding, readings, service connections, and status monitoring.

iii. Decentralized Thermal Storage

Given the opportunity for consumer savings through the utilization of off-peak electricity, the thermal storage component of a solar system could become the most important load management tool.

Thermal storage would be achieved through some sort of storing medium such as rocks, water tanks or magnesite blocks. (15) This method of load management would be particularly well suited for solar heating systems, as the thermal storage component is a major part of the complete system.

3.5 Utility Ownership of Solar Heating Systems

Solar heating systems represent an emerging technology which must compete with (and to some extent complement) an existing utility industry which is already under government regulation. The implications of utility ownership of solar heating equipment involves a number of considerations which will require further study. Since utilities are regulated, any examination of utility ownership involves consideration of the ramifications of government regulation. Other complexities that enter the analysis of utility ownership are that solar heating is a decentralized heating system, which is in sharp contrast to traditional utility policy. In addition, where solar buildings do not rely completely on the sun for their source of heat, utility back-up will be required. (16)

i. Alternative Ownership Policies for Utilities.

There are four basic alternative ownership policies for utilities with regard to solar heating equipment, each representing varying degrees of utility ownership, they are:

a. regulated, monopolitic ownership of solar equipment by utilities;

b. regulated, but competitive ownership of solar equipment by utilities;

c. unregulated competitive ownership of solar equipment by utilities; and

d. competitive solar industry - no utility ownership.

Under a monopolistic franchise of solar heating equipment, utilities would have exclusive rights to construct solar-assisted gas and electrical heating systems. This is already being done by the Southern California Gas Company under its project SAGE (Solar Assisted Gas Energy). (17) Granting an exclusive monopoly to utilities for providing solar assisted heating systems would be accompanied by conventional public utility regulation of the prices and profits of the solar component of the system just as the conventional - gas or electricity - is now regulated. One approach is to set a regulated energy price, such that all energy used by a utility customer whether solar assisted electric heating or solar assisted gas heating would each be charged the typical rate for the particular utility. The utility would then, in effect, own the capital investment in the solar collection system and would set energy prices so as to return whatever rate of profit the regulators would permit on invested capital. Another approach is to allow customers to purchase solar equipment from the utility, with the utility making separate charges for the capital investment (either a lump sum or an amortized installment plan) and for the amount of energy consumed. (18)

A second alternative is to deny utilities a monopoly of the solar equipment market, but permit them to enter the solar energy business as part of their regulated public utility activities. A utility would offer services as in the first case, except that customers could turn to non-utility suppliers to acquire the solar heating component of an integrated heating system.

Utilities would continue to offer both regulated service and regulated solar-assisted versions of the same service, but would face competition in the solar component. A customer could purchase a solar assisted heating system from a utility or continue to buy conventional energy (gas or electricity) from the utility, but add a solar component to his heating system purchased from a third party. Utilities could provide installment services as well.

The third alternative, as the second, involves competitive ownership and control of solar heating systems by utilities. In this case, however, utility activities in the solar business would be provided by a separate unregulated utility affiliate. Solar heating systems would be unregulated, and utilities would face competition from non-utility solar manufacturers. Customers facing either gas curtailments or simply lower total costs from integrated heating systems would select solar equipment from among the unregulated competitors.

The fourth alternative is to prohibit utilities from owning on-site solar heating systems or the heat derived from them. Utilities could investigate the possibilities of using solar energy to generate electricity or gassify hydrocarbon fuels that could be placed in the utility distribution system, but to market solar-assisted heating systems would not be allowed. (19)

ii. Arguments Against Utility Ownership of Solar Heating Systems

The principal argument against giving utilities monopolistic control over the solar market is whether solar equipment production represents a natural monopoly. It is unlikely that decentralized solar technology will, in the near future, exhibit the kind of economies of solar scale that may lead to natural monopoly in the utility sector, there is a presumption that they should be provided in competitive markets.

Regulated utilities can earn profits only on investments in physical capital. Whereas regulation should keep prices below the rates a monopolist would charge, it may lead firms away from providing service at the lowest possible cost. (20) Utilities cannot earn profits on maintenance and installation activities, nor on the resale of energy. This tendency of utilities to over-invest in capital under-regulation for the purpose of expanding the rate base, and hence utility profits, is known as the Averch-Johnson, and Wellisz effect (A-J-W effect) (21) The A-J-W effect, applied to solar systems, would encourage utilities to invest in solar technology that is too durable, that is excessively efficient in converting sunlight to usable energy, and required inefficiently little maintenance. Solar collectors and storage components could be over-designed, leading to excessive costs and prices for solar energy, and inefficiently slow adoption of the technology. (22)

Another argument against regulated utility ownership of solar technology is that regulated utilities can use solar technology strategically to recapture some of the monopoly profits that regulation takes away and to foreclose competition in the solar energy business. In principle, perfect regulation could prevent these problems, but as a utility always knows more than the regulator about the technical and economic conditions facing the firm, regulatory authorities lack the resources and information to maintain perfect scrutiny of utility operations. Therefore, a technological advance that provides more flexibility in firm operations can be used strategically by the utility to work a better deal from the regulated market. (23) As an example, a utility would have to work out a method to allocate its costs between solar-assisted and gas/electricity services only (depending on the utility). If it could succeed in effectuating an allocation that, in fact, attributed too much cost to its conventional energy service (gas or electricity), it would succeed in taking advantage of its monopoly in gas/electricty business to subsidize its solar energy business. Such activity could lead to price discrimination where the conventional energy customers are subsidizing the solar customers. Normally, an unregulated firm would not find such a strategy attractive, but regulation provides the incentive to engage in this behaviour because of the possibility that this strategy will enable the firm to capture more monopoly profits. (24)

Internal subsidization of the sort described above is in the public utility sector, as indicated in the average cost rate schedule in which utilities charge the same price for a particular service, regardless of inter-customer variations in the cost of providing the service. Utilities have been especially prone to internal subsidization to protect against competitive incursions into their markets.

Another problem associated with utility ownership and installation of solar equipment is the issue of third person liability. This involves determining the responsible party (utility or building owner) when solar equipment causes building damage (through leaking, for instance) or increased building maintenance costs (increased roofing repair costs resulting from the need to work around solar equipment). Other problems that exist are anti-trust suits from existing solar manufacturers, as well as adminsitrative and legal costs associated with attempts to include solar costs in the utility rate base. (25)

iii. Arguments for Utility Ownership of Solar Heating Systems

The advantages of encouraging utility participation in the solar market are many. Solar heating is a particularly capital intensive business, and since the construction industry is highly "first-cost sensitive", solar heating is likely to have difficulty finding early, rapid acceptance. A utility is used to high first cost business ventures, and utility selling or leasing of solar equipment could help reduce this barrier.

Utility sponsorship of solar heating systems may help overcome market "fragmentation". If the utility buys and leases the equipment in a large-scale fashion, the solar industry could face two aggregated markets (to the electrical and gas companies). This could actively stimulate the solar industry.

Another significant advantage is that utility companies already have a sales/distribution/service network which operates within the housing industry, the utility company scenario provides a way of "product fitting" solar energy systems.

In addition, given the traditional anti-innovation bias within the industry (a bias which is understandable given the industry environment), utility sponsorship would help overcome some of the traditional "institutional-cultural biases" against solar energy which exists within the housing industry. (26)

Utility ownership of solar heating systems could also encourage their use as tools for utility load management programs (especially electrical load management).

Another factor that favours regulated utility ownership is that pure competition in solar production may prove undesirable. Instability of solar prices and producer incomes, due to inelasticity of supply capacity in the short run, may be one such undesirable result.

Another potential problem with pure competition in the solar industry that might necessitate regulated

ownership by utilities is product quality. Since it is unlikely that solar consumers would be familiar with the many systems available, they would not be guaranteed the realiability that a utility would offer. This problem could be significantly mitigated, however, by requiring certification of solar equipment.

Regulated ownership by utilities is only one solution to the problem and it remains to be determined whether the imposition of quality standards could instead solve the problem and whether the benefits associated with utility ownership and regulation outweigh the benefits of free competition in the solar industry. (27)

The ownership of solar equipment by utilities through unregulated affiliates could result in minimization of solar cost, maintenance of highest possible standards of service, and rapid improvement of both qualities over a period of time.

Another factor in favour of granting utilities the authority to provide solar equipment is that only they face proper incentives for optimizing the choice among energy alternatives. In all but a few cases, the price structure for electricity and gas does not fully reflect the true marginal cost of service, and consequently, the customers of the utility do not face sufficient incentives to switch to solar energy. (28)

iv. Pricing Implications of Utility Ownership of Solar Heating Systems

Utility ownership of solar systems cannot be assessed adequately until some attempt at marginal

cost pricing (peak/off-peak pricing) is instituted. Until this occurs, conventional energy may remain significantly underpriced relative to solar energy and the latter will not be developed to economically efficient levels. Mere institution of a peak load pricing scheme, however, will not solve revenue-cost problems to utilities and consumers resulting from solar adoption, as some studies have indicated. (29)

Marginal cost pricing in the present situation of increasing marginal costs of capacity would lead to excess utility revenues which, under regulation, utilities cannot cover. Thus, the problem of revenue constraint must be addressed if solar ownership and control, whether by utilities or consumers, is to be equitably and efficiently implemented. The theory of marginal cost pricing can deal with the revenue constraint under increasing cost conditions by charging no customer a price exceeding the marginal cost of serving that customer, and establishing a percentage price decrease that is greatest for those customers having the most inelastic demand. (30) Institution of this theoretical flexibility into a peak load pricing scheme has yet to be attempted.

v. Implications of the Various Ownership Alternatives

The implications of the various utility ownership alternatives are summarized in Table 3.4 (31) Proceeding down the table, a gradual transition is made from monopoly and regulation to free competition. It should be noted that these are implications and not predictions of future events. It seems that

IMPLICATIONS OF SOLAR OWNERSHIP ALTERNATIVES

Ownership Alternative	Potential Negative Implications	Potential Positive Implications
1. Regulated, monopolistic ownership of solar by utilities.	1. Lack of economic justification for monopoly. 2. Problems associated with regulation (internal subsidization, revenue constraint, etc.)	1. Optimized solar design for utility load mgmt. 2. High quality of system and service.
2. Regulated, but competitive ownership of solar by utilities.	1. Problems associated with regulation. 2. Quality standards might eliminate need for further economic regulation.	1. Same as above. 2. Advantages of competition.
3. Unregulated competitive ownership of solar by utilities.	1. Possible internal subsidization.	1. Same as above. 2. Utility input could prevent problems of nonoptimized design and product quality.
4. Competitive solar industry--no utility ownership.	1. Problems associated with competition (product quality, etc.). 2. Possibility of nonoptimized solar design to utility consideration. 3. Regulation may develop due to problems associated with competition.	1. Possibly avoid problems associated with regulation.

the best solution to the utility ownership issue would be a balance between utility ownership and free competition and, hence, between regulation and competition. It is suggested that such a balance may best be achieved by a policy resembling the third ownership alternative.

3.6 Utility Financing of Solar Heating Systems

As a final alternative to the participation of utilities in the solar heating system market, utility companies might undertake to act simply as financiers or insurers. Though this would benefit utility customers, as utilities are able to obtain money at preferential interest rates, it may be an undesirable role from the utility standpoint since the profit allowed on its loans is likely to be less than the utility's usual rate of return on investments. Borrowing for solar purposes would also compete with more profitable utility programs, increasing their tremendous capital needs. There have been insulation financing programs by utilities under Ontario Hydro, which have been discontinued, primarily for economic reasons. The amount of money that would be involved in a solar financing program would be substantially greater - insulation is usually a matter of a few hundred dollars; a solar system costs several thousand dollars and up.

IV-4. IMPROVING ACCESS TO SOLAR INSOLATION

4.1 Introduction

Presently, there exists no specific law that guarantees access to direct sunlight for a solar energy user. This fact alone could discourage any potential user from investing in a solar installation. Even if provided with the economic incentives discussed above, he has no guarantee that his investment will be protected.

The appropriate legislation would not only protect a solar collector from a shadow, but in effect, would relieve much of the uncertaintly concerning solar energy utilization.

4.2 Present Laws that Protect Access to Sunlight

For new residential and commercial developments legal mechanisms do exist by which an owner can secure access to sunlight through zoning, restrictive covenants, and express easements. Older and established communities are not able to change by zoning, and new legal approaches are needed. Drastic changes in existing law, or the adoption of new laws radically different from those already in existence, are not necessary to protect the vast majority of solar collectors.

4.3 New Development

When fully exercised, the powers to zone can literally determine the form that a new development will take, from broad outline to minute detail.

In addition to the power to control building heights and orientation, lot size and yard requirements, zoning regulations may control the purpose for which land may be used as well as the appearance of the buildings,

property, and secondary structures. These broad powers contained within zoning laws will enable provincial and municipal agencies to assure solar access in new subdivisions, shopping malls, industrial parks, and small community developments. (1)

i. Restrictive Covenants:

There exist within our legal structure such devices as restrictive covenants to protect a solar user from a shadow. Covenants have the greatest potential for use where new tracts are opened for development; where it is possible to develop some homogenity within the neighbourhood. Using this approach, landowners agree to observe certain restrictions on the use of their land, such as foregoing structures or vegetation which would shadow their neighbour's collectors during peak sunlight hours.

In large subdivisions, covenants can be incorporated into the title document which would guarantee access to sunlight for heating and cooling buildings. They could include restrictions worded as in solar easements (discussed below), or could specify generous setback requirements and height restrictions on trees and structures. These covenants would be judicially enforceable on future owners. The owner of another property lot within the subdivision would be protected should a breach of the covenant occur - as in the case of a solar user "downstream" of an offending property who would also be able to sue - despite his lack of participation within the contract. The use of clear, explicit language is essential for the enforcement of covenants. Otherwise, offenders may have a defense in the lack of specificity of the terms of the contract.

Covenants could be abolished if conditions changed to the extent that the terms defined were unachievable.

This would only apply if the entire restricted area became useless for protected purposes.

The advantages of restrictive covenants are three-fold:

a. they can be used to prevent, usually by injunction, the interference with solar access, thus assuring a continuous supply of light;

b. they cost the government nothing; and

c. provincial or local government could encourage or require their use in new developments. (2)

ii. Express Easements:

Express easements, another private legal device, can be used to protect solar access in both new and existing developments. An easement confers the right to use (not possess) specified parts of another's property for a special purpose. A property owner concerned about shading could negotiate with a neighbour an agreement to access to direct sunlight over the neighbour's land. Easements may be binding in future transfer of ownership, but in others legislation may be necessary to assure continuity of access to sunlight. Agreements must be in writing to be enforceable. If easements for protecting light and air are viewed as protecting people, rather than the parcel of land, then provincial statutes may not enforce the terms of agreement on subsequent owners, although a subsequent owner probably could re-negotiate the terms of the contract.

To attain enforcement, a statute could provide for a description of the extent of coverage under the easement, described in terms of vertical and

horizontal angles extending over the property; the terms and conditions of the grant; and any compensation to be paid to either party involved. Legislation should also ensure that solar easements are recorded along with other land records.

The advantages of express solar easements are:

a. they cost the government next to nothing;

b. they may offer more protection than zoning laws which are subject to review and change; and

c. highly motivated individuals are able to obtain one without the need to go through government red tape.

The disadvantages are:

a. they are voluntary - courts cannot force their sale;

b. their transfer with the sale of the land cannot always be enforced;

c. their cost is uncertain, and enforcement through the court system can be costly for the property owner; (3)

d. neighbours are unlikely to go through the trouble and expense of drafting a legal document, particularly where they know or trust one another - the trouble therefore starts when one of the parcels changes hands;

e. quite a few owners may have to be included in easement negotiations as the value of an easement may be reduced to zero if a very tall structure is erected on a lot slightly further away, and shades the property of both the recipient and the grantor of the easement;

and

f. express easements put the entire cost on the would-be solar property owner. Public policy may suggest that the cost should be shared or that the builder of the interfering structures should pay solar heating users for their "natural resources" (solar energy) rights.(4)

iii. Eminent Domain:

Federal and provincial governments have the powers to authorize the taking of property for public use through the powers of eminent domain. Such powers would enable the government to condemn skyspace for sale or lease to solar energy users, as has been suggested by several researchers. (5) There is some question, however, whether such taking of property would be a legitimate public use, as the immediate benefit would favour private users, despite the ultimate beneficial impact on conventional energy and environmental resources.

The provincial legislature could enact a statute declaring that it is in the public interest that skyspace for solar collectors be created and maintained so as to enable the efficient operation of solar heating systems.

Assessment of the costs of a solar skyspace and related costs would be made against potential skyspace users on an annual basis that represents a twenty-year payback of such costs plus interest. Where a particular solar skyspace provided insolation to multiple users, the costs would be allocated in proportion to the annual amount of solar insolation utilized by each user from the particular skyspace protected.

The disadvantages associated with the use of an eminent domain approach to solar skyspace access include:

a. extensive bureaucratic action would be required;

b. complex mechanisms for determining the dollar value of condemned skyspace must be developed;

c. owners and developers would be unduly blocked from using lands affected by the condemned skyspace, even though many areas would not block potential collector sites;

and

d. enforcement of condemnation proceedings would be likely to cause litigation between neighbours.

iv. Land Use Planning:

Commonly used techniques that could promote the utilization of solar energy in new developments include comprehensive city and county plans, energy impact statements, and flexible zoning techniques.

Comprehensive plans used to guide long range local zoning could include elements pertaining to solar energy utilization.

Environmental impact statements discussing the effects of a project on energy consumption, or measures to conserve energy resources, might be used and made to include considerations for solar heating systems.

Under flexible zoning techniques, builders, in order to gain approval of their plans, could be required to submit solar impact statements indicating where shadows would exist and to justify designs that would create shadows. Projects that include the above factors in their design could qualify for the incentives proposed in the section of this report

on tax incentives.

v. Solar Energy Use Districts:

In a Mandatory Use District, if a solar energy system was economically justified in a new structure, use of solar heating would be required. All developments would be zoned with the purpose of immediate or future implementation of solar systems. Skyspace could be protected by city action if private agreements could not be reached.

The same municipal protection could be offered in Affirmitive Solar Use districts. Building codes in both Mandatory and Affirmitive districts would be revised to encourage solar heating.

A third category, Other Solar Use Districts, would receive skyspace protection for most uses and be granted exemptions from other hindering regulations.

4.4 Existing Developments

The most common legal tool for protecting solar rights in existing developments is the express easement, although solar zoning districts could be established within existing communities as well.

A zoning device employed in Los Angeles may be adequate to protect solar access in developed as well as new neighbourhoods. Transition neighbourhoods where a commercial development borders a residential section, will be one of the most difficult areas in which to assure solar access. If a newly zoned commercial area is south of an existing residential neighbourhood, the taller buildings may cause shading problems. Los Angeles zoning regulations deal with this by restricting structures in these areas to six and three stories. By "stepping

down" building heights, there is less contrast and fewer shading problems in the transition zone. (5)

New solar access zoning laws must reflect the needs of different zones, and must consider the total energy impacts of the different building types, before making provisions for solar access. For instance, in conventional zones, existing buildings are often just as tall as the zoning laws allow, and could not, therefore, increase their height by even the thickness of a collector.

4.5 Criteria for Evaluating New Laws and Proposals

In order to evaluate proposals offered for solar skyspace protection, they should be tested against the following objectives:

"1. Maximize protection from shadows during the hours of high insolation to reasonably located active-type collectors for new structures.

2. Maximize protection of a similar nature to passive systems in new developments.

3. Maximize protection to propterty owners retrofitting their homes with cost-effective solar devices in established neighbourhoods where the use is in accord with existing zoning and, where due process has been given affected, nearby landowners.

4. Deny protection in retrofitting cases where the burden that would be imposed on a complaining neighbour clearly outweighs the potential benefit to the owner of the solar building.

5. Have a built-in flexibility to adapt to the availability of new technologies.

6. Minimize the administrative expense to the structure's developer, builder, and owner; and to the enforcing jurisdiction.

7. Minimize delay.

8. Arbitrate differences between neighbouring landowners to reduce the likelihood of litigation between neighbours.

9. Allow private, alternative agreements among adjacent property owners.

10. Be politically acceptable.

11. Provide for all types of property zones.

12. Include standards for zoning boards telling them when variances or special uses should be allowed."

(6)

4.6 A Model Solar Skyspace Rights Act

As there is presently no guaranteed access to sunlight for solar energy supporters, the following model law will give a framework in which to consider and create such a statute. The statute should provide that owners of property have the right to uninterrupted skyspace directly above all owned or leased property.

The statute could further provide for the existence of a valid skyspace easement:

"a. in consensual easement agreements between property owners;

b. where limitations on height or location of structures are imposed through regulations, and where the owner has an actual or proposed collector, or where a collector is designated to use such skyspace;

c. through prescriptive rights gained through use or intended use of unoccupied airspace without interruption for at least seven years commencing at any time subsequent to the enactment of this provision where the space is used or to be used for a collector, provided that:

1. all persons owning the skyspace or servient estates in which the skyspace is located shall not have applied to the municipal government for registration during the period. Registration shall have:

   i. identified the dominant and servient lands;
   ii. stated that registration is equivalent to obstruction of skyspace in part or completely by construction; and
   iii. petitioned the municipality for a permit to obstruct the skyspace through construction, and after notice and opportunity for a hearing to owners of all affected solar energy systems, the municipality shall have granted the permit;

2. the owner of the skyspace has actual notice of the collector, or the collector and skyspace have been designated by the municipality.

   When a person owning a servient estate petitions the municipality for a permit to obstruct skyspace subject to prescriptive rights, the municipality shall approve the permit for construction or approve alternative construction where:

   i. sound land use and energy planning for the entire community and the site require the obstruction or construction;
   ii. all feasible attempts have been made by the petitioner to supply supplementary energy or solar insolation or other energy to the person in the shadow area;
   iii. denial of a permit would cause substantial hardship to the owner of the skyspace; and
   iv. the municipality has attempted to provide a feasible location for a solar collector or a cost-effective solar enegy system for structures in the shadow area.

The statute should further provide that no solar skyspace utilized by a collector shall be blocked or obstructed primarily by a new collector constructed upon an existing structure or on an independent structure without the consent of the owner of the collector utilizing the skyspace."

In Alberquerque, New Mexico, the County Planning Department is embarking on a very forward-looking "policies" plan. Included in their policies relating to energy are such statutes as:
"The City and Council shall encourage fuel conservation practices and promote the most efficient use of existing energy supplies"; and
"The City and County shall pursue land use planning that will maximize potential for energy conservation." (8)

Included among many "possible techniques" proposed accomplishing these objectives are comprehensive zoning methods and revision of building codes, with provisions made for the utilization of solar energy.

4.7 Government Action

Actions taken by the Provincial government with technical assistance from the Federal government might:

i. require that new developments include provisions for sunlight through the use of restrictive covenants, height restriction, zoning methods, and other traditional land use controls. Since solar energy is likely to become more economical for newer buildings than for existing ones, this approach could significantly mitigate the problem.

ii. review the economics of utilizing solar heating and cooling in existing buildings in different parts of the province to determine their cost-effectiveness, according to local fuel costs, heat requirements,

types of buildings and local climate. In some parts of the province where solar energy is unlikely to be introduced in the near future, comprehensive legal protection may be premature.

iii. where solar technology is found to be economically competitive, determine whether shading is a problem by using aerial photographs, and educate individuals to inspect their own situation.

For existing buildings, where it is determined that solar installations are economically viable, yet shading problems widespread, actions would include:

a. informing property owners of their right to negotiate light and air easements. Legislation could facilitate the process by creating a simplified system for recording of easements to eliminate the added expense created by involving a lawyer;

b. restricting any new vegetation from imposing a shadow on an existing solar collector;

c. adding solar energy impact assessments to the list of factors considered in comprehensive plans submitted by developers to qualify for a building permit. This would ensure that potential conflicts with solar energy systems are considered when applications are submitted for rezoning or building renovation, without necessarily specifying the resolution of particular problems. (10)

The above proposals should be adequate to ensure that access to solar insolation is a certainty for the majority of solar energy users. There may occur, however, instances when additional measures would be necessary: for example, if a neighbour refused to negotiate a settlement and proceeded to interfere with his neighbour's sunlight out of spite.

In this case the following procedures are justifiable: Adopt legislation declaring that solar energy utilization is a justified public benefit and is in the interest of the public health, welfare and safety. More specifically, the legislature could specify the purpose of solar energy utilization in terms of public benefit and give preferential treatment to solar users in situations where competing uses clearly serve lesser public interest. Actions such as erecting a high fence or decorative addition that may interfere with the operation of a solar collector could be treated as a public nuisance, unless such an addition was definitely of greater public interest.

The town of Kiowa, Colorado, has passed a zoning ordinance allowing a property owner with a solar collector to have a structure declared a public nuisance if it interferes with his solar collector. (11) As such an ordinance is concerned with public safety and health, it comes within the jurisdiction of the police powers. Though the police powers are limited by certain constitutional rights, and do not have the power to arbitrarily invade property rights, they do have the right to protect the interest of the general public. If allowing direct access of sunlight to solar collectors alleviates a growing energy shortage, requiring less dependence on increasingly uncertain resources, and preserves a local community's economy - pollution free - it should qualify constitutionally as a reasonable regulation necessary to preserve the public order, health, safety and welfare. (12)

Even where legally possible, there are certain drawbacks associated with the use of a public nuisance approach for protecting solar access:

i. lawsuits would be necessary in each individual case to prove the existence of a nuisance;

ii. in some cases, the owners of offending property may truly deserve compensation;

iii. there would be no security available for collector owners until after they had installed a collector and won a nuisance suite; if one tried to sue before installing a collector, the suit may be dismissed as being premature. (13)

4.8 Conclusion

A combination of approaches will probably cover the solar access issue more effectively than any one particular approach.

Protecting access to solar insolation will be a difficult matter in existing densely populated areas. In general, legal problems will not be critical because many existing structures are not suitable for complete solar heat delivery systems. For those that wanted to supplement their heating capability with solar energy, available unobstructed roof space should provide the surface area for such a requirement.

Provincial legislation should encourage the development of new subidivisions, malls and industrial parks with considerations given to include solar heating and cooling systems sometime in the future. The use of covenants to protect sun rights of all property owners should be mandated as well as comprehensive land use plans.

IV-5. BUILDING CODES

5.1 Introduction

Existing building codes were drawn up at a time when solar heating technology was not significantly advanced and readily available, and so provisions to include solar heating systems in code standards were not made. With an increasing interest in alternative technologies, however, revision of the present building codes is necessary to ensure their proper use and installation. Although building codes have not yet been serious barriers to solar heating, the typical building code provisions for testing, and approval of new materials and systems may be serious potential barriers.(1)

A building code is a set of regulations relating to building construction that defines terms, sets standards for materials and equipment, tells how materials and equipment may or may not be put together, and provides for enforcement through permits and inspection. The provisions contained in definitions can be of critical importance. As an example, "height" may not include heating, ventilation, and air conditioning equipment on a roof. A "heating appliance" may not include equipment that does not burn fuel or use electricity to produce heat. Definitions may also determine who may perform the work on a solar installation; for example, certified plumbers may be required to do all the "plumbing" work associated with the solar system.

The standard provision of building codes are generally of two types. Specification standards specify what kinds of materials and equipment may be used and how. For example, glazed glass must be over a minimum thickness; 18 ounzes for a 120 inch perimeter. Performance

standards, on the other hand, merely indicate what the particular part of a structure must be able to do. For example, certain walls must have a fire resistance rating of one hour. Specification standards are easier to administer, but are inflexible. Performance standards are flexible and allow for innovation, but also require more trained personnel, time and money to administer.

The manner in which codes are administered and enforced are also very important. Before any construction is carried out, be it a new development or a renovation of an existing building, a building permit must be obtained. In order to qualify for the permit, a building official will ensure that all details in the plan submitted conform to code requirements. If the plan specifies conventional materials, equipment and methods that are provided for in code specification standards, approval is routine. If the plans call for innovative materials or systems, however, the building official may approve or reject the plans, or require testing and submission of evidence that the construction proposal is in no way inferior to the conventional construction provided for in the code. This takes considerable time and costs more than the routine procedure, and approval is not assured. (2)

There is a predominating assumption that because there exists no provision for solar heating systems in building codes, then there is no barrier in the codes. (3) However, it is the lack of provisions and explicit definitions in the building codes that leaves the criteria for cerification of solar equipment open to interpretation of existing codes. This will ultimately result in delays, added expense and inconvenience to the owner.

5.2 Revision of Building Codes

In order to remove what could be a potential barrier from existing building codes, the provincial legislature could enact a law requiring all local governments to revise their building codes and procedures to permit the qualified installation and use of solar heating systems in cost-effective configurations.

The legislation should require that all governmental entities examine regulations covering materials used in construction, alteration or maintenance of structures, methods of construction or alteration, and the provisions of heating and utility services to a structure in order to determine whether such controls unreasonably interfere with the use of solar heating systems.

5.3 Conclusion:

As solar heating systems are not specifically provided for in the existing building codes, they are vulnerable to testing and approval requirements that could make them less competitive than conventional systems due to the uncertainty, delay, and expense in processing permit applications.

The best long-term solution to this problem would be nationally recognized standards and testing procedures for solar heating systems, and a recognized accreditation office that would certify compliance with these standards and grant listings. These standards would be adopted by reference in the Ontario Building Code, and listings would be accepted as sufficient proof for code approval -

provided the equipment is installed in compliance with conditions given in the systems on the same footing as conventional heating systems. (4)

Provisions in building codes that unreasonably discourage solar systems should be sought out and revised, in order to facilitate the implementation of solar heating as a viable alternative to conventional heating methods.

"The building code dilemma must be resolved at the local level with the aid of people who have been involved in modelling codes in the past as well as solar energy people." (5)

V - CONCLUSION

It is felt by many experts that in order for solar heating to gain widespread acceptance, a certain kind of public awareness must be cultivated. Before designers, developers and contractors begin to include solar heating systems in their plans, they must believe such alternatives are practical, economical and readily available.

Up to this point in time all solar installations have been either government funded pilot projects, or private ventures made in the face of considerable disincentives, i.e. no guaranteed low interest borrowing, no guaranteed insurance, no income tac or municipal tax incentives, no guaranteed sun rights, no assured product reliability or established minimum standards, and unwarrantedly high costs due to custom design of each solar installation. In effect, solar energy use can appear to be a very risky venture, practical only for projects financed by governments, or by large institutions able to put up the initial capital outlay and afford the wait until their investment provides a long term return. This has been the case on the past, and largely persists up to the present time.

The scenario for the future, however, should show the practical realities of solar energy use by creating a sense of awareness on the part of the speculative builder/developer in the residential and commercial markets. It must be appreciated that the kind of awareness that leads to effective action is not built up suddenly in any segment of the construction industry and, therefore, must evolve from the experience gained from pilot projects undertaken locally, and information exchanged freely between provincial, national

and international government organizations. Given the appropriate legislative incentives, however, and a comprehensive program for their implementation, the awareness required for the widespread utilization of solar heating could be rapidly achieved.

A solar heating program could create circumstances in which:

a. "results of demonstration programs are publicized showing positively that solar systems perform satisfactorily and reliably;

b. manufacturers make available and actively promote system components and packaged systems for easy installation; and

c. the average homeowner is educated to the difference between solar systems and conventional systems, in terms of life-cycle costs, maintenance requirements, the need for storage, and how the system is utilized." (1)

Successful market penetration by solar heating systems will also depend upon awareness:

a. on the part of a property buyer that solar heating systems are cost-effective while at the same time allowing the owner to satisfy his desire to be an innovator and a protector of the environment;

b. on the part of architects and engineers that conservation should be an integral part of

good building design, and the inclusion of solar systems in building heating systems is cost-effective, practical and workable; and

c. on the part of the custom design builder that solar systems are a commercial reality, cost-effective and readily available. (2)

The issues at hand are not only a matter of provincial priorities, but also of national concern. The development of this required awareness is a slow iterative process in which government,manufacturers of solar equipment. trade associations, and visionary but practical leaders all play an important role. The potential benefits associated with the use of solar heating may be of marginal importance to the individual user, but of transcendent importance to the nation as a whole. Such benefits refer primarily to energy conservation and pollution abatement - clearly matters of national concern. (3)

The adoption of solar heating technology will depend on such factors as effective legislative action, and well designed statutes and ordinances,coupled with incentives for the establishment of a viable solar industry. A combination of these factors could produce an early widespread adoption of solar heating as a significant alternative to conventional heating systems.

An especially important consideration in provincial and local adoption of new laws is that the model bills, and suggested legislation, be adopted to case law, to existing laws and to the factual situations in which solar energy is utilized. (4)

"Bills adapted carefully to loacl needs will serve better to enhance the potential for widespread solar energy use." (5)

In conclusion, the government is in the position of legislating inducements to the widespread use of solar heating, and removing many of the barriers confronting such use.

Technological innovations have been instrumental in shaping our changing society, and the effects of a solar technology are certain to be noticeable if accepted on a wide scale. The changes associated with solar heat utilization should, however, generally benefit the public both economically and aesthetically.

The economics of a solar heating system, in terms of energy per dollar, appear to justify the capital investment required for a solar heating unit, if amortized over the expected lifetime of the heating system, when one considers the cost to deliver the equivalent amount of energy by energy resistance heat. If adopted on a widespread basis, it has been estimated that solar heating will impact on electrical utilities by reducing peak requirements by 0.3 - 3.6% in 2001 and 1.24 - 4.6% in 2021, depending on the extent of solar energy penetration. (6)

In addition, the widespread use of solar heating would require the energy efficient design of all buildings in order to make the solar installations cost effective. The general public would learn to utilize energy resources in a more conservationary fashion, and the dependence on non-renewable energy resources would be reduced; a need that will most certainly predominate in the future.

The role of the government concerning the acceptance of any new technology is to pass legislation, where needed, to make the use of such a technology as available and as acceptable as possible - provided that the technology does not constitute a significant public health or safety hazard, and is in the general public interest. Other, non-legislative matters, such as supply of and demand for the particular technology and equipment, are subject to the mechanisms of the market place in order to gain widespread acceptance.

A methos of facilitating this acceptance would be through a government supported demonstration program. Solar heating systems would be installed on all new and renovated government and public buildings, where such installations would be cost-effective. With additional legislative actions, such as recognizing sun rights, providing an economic incentives package for purchasers, and implementing a Solar Heat Utilization Program, the market penetration os solar heating technology could be a rapid and successful one.

APPENDIX A

DEFINITIONS

APPENDIX A

Definitions from "New Laws to Encourage Solar Energy Use for Individual Buildings", R. L. Robbins, Lake Michigan Federation; Chicago, Illinois, June 1976, Appendix 2, p.3.

In the final report, a key item of importance is the definition of terms. This is important in remedial legislation adopted to encourage solar energy systems.

(A) A definition for solar skyspace should be utilized with appropriate modifications in legislation adopted. This definition recognizes that solar skyspace is the area that needs to be protected to discourage blockage of sunlight for collectors.

The term describes a three dimensional space in the sky extending from the collector to the location of the sun. This is the airspace above the ground which must be kept clear of obstructions if a solar collector is to receive the maximum amount of solar energy. A sample definition of skyspace follows:

(1) the maximum three dimensional space extending from a collector to the location of the sun: where a solar energy system is utilized for heating, to all locations of the sun between 9:00 a.m. and 3:00 p.m. Local Apparent Time (LAT) between September 22 and March 22; where a solar energy system is utilized for cooling, to all locations of the sun between 8:00 a.m. and 4:00 p.m. LAT between March 22 and September 22; and where a solar energy system is used for heating and cooling or for hot water uses, to all locations of the sun throughout the year between [...add hours here...].

(2) Where a solar energy system is used with long-term storage for the above purposes or with other variations or for a process or other function utilized in any period, skyspace shall be described to cover the related period required for maximum use and reasonable limitations for the process or function.

(3) A passive collector shall be considered a collector for these purposes.

The definition does not include hours of the day immediately following sunrise or immediately preceding sunset, since little solar energy is received during those periods.

Local Apparent Time (LAT), and not Standard Time or Daylight Time, is used in calculations of solar location so as to insure that actual , or close to actual, locations are plotted. LAT is an extremely close approximation of the actual time at a given location, considering the longitude adjustments to standard times.

Where solar energy is used for other purposes or for long-term storage of energy, periods other than those seasonally designated can be utilized.

A passive system using walls for storage and collection or glassed-in building space should be considered a collector for purposes of describing the solar skyspace and protection from obstruction.

(B) The definition of solar collector is also critical to discourage fiscal subsidy or law changes which do not benefit solar energy use and to encourage proper changes in laws. A solar collector can include:

(1) An assembly, structure, or design used for gathering, concentrating, or absorbing direct and indirect solar energy, specially designed for holding a substantial amount of useful thermal energy, and transferring that thermal energy to a gas, solid, or fluid, or for directly utilizing the heat. Components of passive systems are also considered collectors;

(2) A mechanism used for absorbing direct and indirect solar energy and for converting it into useful electricity for an energy system;

(3) A mechanism or process used for gathering solar energy through photosynthetic processes, wind, thermal gradients in water and organic wastes, and components used to transfer the thermal energy to a fluid, gas, or solid or for transforming it into electricity.

The first paragraph of the "solar collector" definition refers to the usual devices now used for collecting solar energy.

Paragraph (2) describes devices used for a direct conversion of solar energy into electricity. These devices consist of photovoltaic cells under glass. Sunlight impact directly generates electricity. The devices differ substantially from the flat plate collector and from the passive systems to merit a specific definition.

Paragraph (3) considers forms of solar energy collectors other than the direct and indirect use of incident photon energy.

Collectors which need skyspace protection may be in existence, under construction, or proposed. The three stages often merit different attention in various laws. They are defined as follows:

Actual solar collectors are those in existence or under construction. Proposed collectors are those being designed or officially approved for construction. Designated collectors are those whose location has been specifically designated on a map by the municipality through zoning or other official procedure such as a comprehensive plan, official map, or policy statement.

The inclusion of all three types insures proper changes in land use controls, effective fiscal incentives, and protection of skyspace prior to investment in systems.

(C) A solar storage mechanism is utilized for holding solar energy for periods when sunlight is required but unavailable. It can be defined as equipment consisting of fluids, solids, and gases, such as water, air, rocks, salts, batteries, or other materials, and the heat exchangers, containers, piping and transfer mechanisms, and controls utilized for storing the collected solar energy for energy system use, including structural elements used in passive systems and structural requirements for storage , and including biomass locations and biomass storage locations and methods.

The definition encompasses, among,other things, heat exchangers and passive elements such as walls, floors and other areas specially constructed for solar energy needs.

(D) Another key term is solar energy use. Several alternate definitions are presented below, since it may be necessary to utilize a different definition for each statute's particular usage of the term. In any event, minimum performance standards should be included in the definition to limit or avoid the problem of unused or ineffective solar energy systems which are of no public benefit.

Solar energy use is defined by five different methods:

(1) The use of solar energy for __% of the electrical needs of a process, lighting, cooling, or heating;

(2) The use of solar energy for __% of the heating (and) (or) __ of the cooling needs of a structure or process;

The use of solar energy for a percentage of heating, cooling, or electrical requirements consistent with the amount of incident solar energy in the STATE or municipality, collection efficiency, energy needs, relative cost of solar and conventional energy systems and fuels, and available conservation practices, as defined by the STATE through regulation;

(4) The use of solar energy for a percentage of heating, cooling, or electrical requirements consistent with the maximum amount of incident solar energy at the best point of collection, costs, and processes for increasing sunlight access, collection efficiency, existing and potential structures and vegetation, and the cost of solar and conventional energy systems and fuels and available energy conservation practices all measured for a given commonly-owned structure or structures;

(5) The use of energy sources for conventional refrigeration, freezing, cooking, or other small appliance and lighting operations shall not be considered in total or nonsolar heating and cooling use by a structure or process.

In addition "use" calculations should consider annual average operation except during the initial two years of operation when peak monthly uses or percentages of uses for heating or cooling shall be considered as monthly uses or percentages of uses for the entire two year period. For nonfiscal and fiscal purposes related to construction loans, use calculations shall utilize design capacity during the first two years of operation except as otherwise determined by a responsible administrative agency. A process includes the heating or cooling of water for use, or the heating or cooling of other substances.

(E) It is desirable to include a broad definition of structure, especially to include as many objects as possible within the limits of height and other restrictions to protect solar skyspace.

Structure is anything constructed or installed or portable, the use of which requires a location on a parcel of land, including a movable structure which is located on land suitable for housing, business, commercial, agricultural, or office purposes, either temporarily or permanently. Structure also includes fences, billboards, poles, transmission lines, antennas, tracks, advertising signs, solar energy systems and components, and vegetation.

(F) A definition of solar energy system is critical to solar energy legislation. A broad definition which encourages many forms of solar energy use would include all of the subsequent definitions and the exclusions.

(1) A solar energy system includes a complete assembly structure or design of a collector, storage mechanisms, and distribution equipment which uses solar energy for heating or cooling space, fluids, gases, or other materials, or for generating electricity.

(2) A solar energy system includes the design, maintenance and labor components, and the auxiliary conventional sources of energy to the extent they are unique to solar energy utilization.

(3) A solar energy system includes legal, financial, and institutional mechanisms required to insure continued access to solar energy and its use in a solar energy system.

(4) A solar energy system includes methods used for cooling and heating by means of passive systems, nocturnal heat radiation, or by evaporation, or other methods of meeting peakload energy requirements at nonpeakload times through use of solar energy and component systems.

(5) A solar energy system includes methods of utilizing photosynthesis or biomass for heating or cooling and the components of such systems. Such solar energy systems shall also include the use of vegetation for shading and windbreak.

(6) A solar energy system includes methods for utilizing solar energy for agricultural purposes including greenhouses and conventional agricultural methods.

(7) A solar energy system does not include distribution equipment that is equally usable in a conventional energy system, except for those components that are unique to requirements for efficient solar energy utilization. Also excluded are components of a solar energy system to the extent that they serve other needs, including structural, insulating, shading, protection, or aesthetic use as well as other uses, and the components of distribution equipment which are not unique to a solar energy system, involving the collection of solar energy in a single location for use by more than one landowner or use, except to the extent that each landowner or user is unable to efficiently construct a solar energy system for sole use.

(8) Another definition could be done by provision which defines a solar energy system as that system which is certified as complying with standards of some government or private accrediting or approving agency such as the National Bureau of Standards or Underwriters Laboratories. This could be used when the complexities of measuring the extent of a solar energy system under the definitions exceeds the capacity of existing state agencies or officials.

(9) A solar energy system definition could merely presume that a solar energy system qualifies for purposes of the definition, unless a state agency concerned with consumer protection or solar energy rules that the solar energy system or component was sold subject to improper sales practices or was not qualified for some other reason.

(10) Cost-effectiveness may also be part of a definition. Laws which encourage solar energy use could be directed solely at cost-effective solar energy systems. These could include those in which the annual cost of operation including costs of installation and repayment of principal and interest over the life cycle of the system do not exceed by more than ten percent the annual cost of an optimally located and designed system on that site which has a totally unobstructed skyspace except for existing structures, and is optimally situated, designed, and constructed solely with consideration of existing structures on the user's land and existing structures blocking solar skyspace.

Alternative definitions of cost-effectiveness could provide that a system is cost-effective where construction and operation costs over its life cycle are within a stated percentile of other solar energy systems in the area, or where such costs, considering tax or other fiscal benefits, are not more than the life cycle costs of using the lowest cost generally used conventional energy sources available.

Even though the purpose of the legislation described below is to encourage the use of solar energy systems, it would be unfair and futile to require solar energy systems, if they were unavailable or excessively costly. An available solar energy system could be:

(1) A system where for the particular use or installation: components of the system are regularly supplied or can be readily fabricated at reasonable cost; technical skill is available for design of the system as well as specification of components; capacity to install and maintain the system exists in reasonable proximity to the installation; and insurance, financing, and legal obstacles do not bar the use of solar energy systems.

(2) A system where the municipality (or state) has certified that the above conditions exist in a municipality, a region, or in an entire state.

(3) A system where the owner or user of property subject to solar energy requirements or a municipality, utility, individual, or agency required to encourage solar energy use, has not presented substantial evidence that the above conditions do not exist.

(H) A conventional energy system is a gas, oil, fossil fuel, nuclear, or hydroelectric energy system including supply elements, furnaces, burners, tanks, boilers, related controls, distribution pipes, and room or area units, and including electrical distribution and use system other than solar photovoltaic cells and associated components unique to a solar energy system.

APPENDIX B

MODEL LEGISLATION

APPENDIX B

Following are selected summaries of the State Solar Energy legislation that has been passed in the U.S. between 1974 and Spring 1977 from "Analysis of Policy Options for Accelerating Commercialization of Solar Heating and Cooling Systems" , R. Bezdek, et al, Program of Policy Studies in Science and Technology; George Washington University, Washington, D.C., April 1977, p.458.

A. Property Tax Incentives

Montana: H.B. 663

Exempts from property taxation the amount of any capital investment in a defined non-fossil form of energy generation (specifically solar heat, wind, solid wastes, organic wastes, and small water power systems). The appraised value of the investment to be exempted from property taxation may not exceed $100,000. The taxpayer must apply to the state department of revenue for this tax exemption, using application forms provided by the department.

Georgia: Res. 167, 1976

Proposes an amendment to the Georgia Constitution to authorize any county or municipality to exempt from ad valorem taxation all of the value of tangible property used in a solar energy heating or cooling system, and the value of tangible property consisting only of machinery and equipment directly used in the manufacture of solar energy heating or cooling systems. A solar energy heating or cooling system includes all controls, tanks, pumps, heat exchangers, and other equipment used directly and exclusively for the conversion of solar energy for heating (includes water heating and drying) or cooling: excludes walls, roofs, or equipment that would ordinarily be contained in the structure. This amendment was adopted by the Georgia voters in the 1976 November election and will be effective until 7/1/86.

Hawaii: SB2467, 1976

Exempts alternate energy improvements from the property tax, provided the alternate energy improvements were installed after 6/30/76 but before 12/31/81. Application for the exemption shall be made to the director of taxation. Alternate energy improvements are those on any building which result in the production of energy from a source, or by use of a process which does not use fossil fuels or nuclear fuels; or an increased level of efficiency in the utilization of energy produced by fossil fuels or in the utilization of secondary forms of energy dependent upon fossil fuels for its generation.

Michigan: Act 135, 1976

Exempts a solar, wind or water energy conversion device from property taxation. The owner of such a device must file with the township or city assessor an application for a solar, wind or water energy tax exemption certificate. A solar, wind, or water energy conversion device means a mechanism or series of mechanisms designed primarily to collect, convert, transfer, or store for future use solar wind or water energy for the purposes of heating, cooling, or electric supply, but not those parts of a heating, cooling or electric supply system that would be required regardless of the energy source being utilized.

Vermont PA226, 1975

Permits each town to exempt alternate energy sources from real and personal property taxation. Alternate energy sources include grist mills, windmills, facilities for the collection of solar energy or the conversion of organic matter to methane, and all component parts thereof including land upon which the facility is located, not to exceed one-half acre.

B. Income Tax Incentives

Arizona: Chapter 93 Laws of 1975

Permits any taxpayer to amortize over a 60-month period the value of a solar device producing either heat or electricity. This amortization rate is allowed as a deduction when computing net taxable income for state income tax purposes. The deduction applies to all solar installations for residential, commercial, industrial or governmental uses, or for experimental or demonstration purposes. The deductible value of a solar device includes its acquisition and installation costs, of which the latter may include special construction or remodeling costs attributable to the solar device.

Arizona: Chapter 129, 1976

Permits any taxpayer to amortize over a 36-month period the value of a solar device producing either heat or electricity. This chapter amends a 1975 law setting the amortization period at 60 months (see Chapter 93, 1975).

Idaho: HB468, 1976

Provides individual taxpayers an income credit of 40% of the cost of an alternative energy device in a taxpayer's residence and a 20% income tax credit each year thereafter for a period of three succeeding years. A deduction cannot exceed $5,000 in any one year. Cost includes construction, reconstruction, remodeling, installation or acquisition of an alternative energy device. An alternative energy device means any system or mechanism or series of mechanisms using solar radiation, wind, geothermal resource,

or wood or wood products primarily to provide heating, cooling, electrical power, or any combination thereof. An alternative energy device includes a fluid-to-air heat pump operating on a fluid reservoir heated by solar radiation or geothermal resource. A built-in fireplace does not qualify as an energy-saving device unless it is equipped with a metal heat exchanger that will deliver heated air to a substantial portion of the residence and is equipped with control doors and a regulated draft.

Hawaii: SB 2467 1976

Provides an income tax credit of 10% of the cost of a solar energy device for an individual or corporate resident taxpayer who has a solar energy device in place after 12/31/74 but before 12/31/81. If the tax credit exceeds the taxpayers income tax liability, the excess may be applied to the taxpayer's liability for subsequent years until exhausted. The director of taxation shall prepare such forms as necessary to claim a credit. A solar energy device means any new identifiable facility, equipment, apparatus, or the like which makes use of solar energy for heating, cooling, or reducing the use of other types of energy dependent upon fossil fuels for its generation.

C. Sales and Use Tax Incentives

Georgia: Act 1030, 1976

Exempts receipts from the sale or use of machines and equipment used directly in the conversion of solar energy for heating, cooling, drying, or water heating from state sales and use tax. Machines and equipment include controls, tanks, pumps, heat exchangers and other equipment used directly and exclusively for the conversion of solar energy; excludes walls, roofs, or equipment ordinarily contained in a structure. A purchaser must file a claim for refund with the state revenue commissioner in a manner authorized by General law. This sales tax refund will be effective until 7/1/86.

D. State Financed Energy Research and Development of Solar Technologies

Florida: S.B. 721 (1974)

Effective July 1, 1974, the act directs the Board of Regents of the state university system to develop a plan for a state solar energy center. The stipulated purpose of the center is to promote research and development of solar energy, disseminate information on the results of such research, and to demonstrate the capability of solar energy systems to provide energy resources to the state. The Board of Regents plan must recommend: a location for the center; an organization structure; a definition of the program; and its associated budgeting requirements.

The enabling legislation intends for the center to be integrated with the existing technical and personnel resources of the state university system, and to coordinate their diverse activities regarding solar energy development. Some aspects of the solar energy center's program are identified by the legislature as: developing methods for testing solar equipment; participating in solar demonstration projects; developing and disseminating solar energy information; providing technical assistance to state agencies for the development of solar information and standards; and providing educational services to persons working with state-of-the-art and advanced solar energy technologies.

In 1975 the Board of Regents plan in compliance with this act was approved, and the legislature appropriated one million dollars to support the Florida Solar Energy Center.

Hawaii: S.B. 1586

Hawaii has initiated the financial support of a state-wide research and development program for renewable solar energy resources. This funding support builds upon the related legislative enactments of 1974 which created the institutional mechanisms required to identify and then administer a natural energy program for the state.

In 1974 the legislature established the Hawaii Natural Energy Institute to coordinate and undertake the development of non-polluting natural energy sources for the state. The Institute functions as a research unit of the University of Hawaii-Manoa, which had $55,000 appropriated to it for planning and developing the structure and operation of the institute.

A related enactment of 1974 created the natural energy laboratory of the State of Hawaii under the direction and management of a consortium of the State Department of Land and Natural Resources, the University of Hawaii, and the County of Hawaii. The legislature appropriated $50,000 (to be equally matched by the county) for the laboratory's establishment.

These accomplishments of 1974 led to Hawaii's appropriation in 1975 of $1,787,000 over the next two fiscal years to the Department of Economic Planning and Development for developing and utilizing alternative energy sources. Of that amount, $218,000 in 1975-76 and $324,000 in 1976-77 will support the Hawaii Natural Energy Institute; $100,000 in 1975 and $150,000 in 1976-77 is allocated in support of the Hawaii Natural Energy Laboratory.

The director of the department, who also serves as the state energy resource coordinator, will contract with the University of Hawaii and other state and private agencies to carry out the research, development and demonstration of alternative energy sources as categorically specified in the appropriations bill. The appropriation defines the purpose of the research funding as follows.

Resource	Funding in $1,000s	
Applications and Demonstrations	75-76	76-77
Solid Waste	75	30
Hydroelectric	50	50
Solar (water heaters and air conditioners)	120	80
Research and Development		
Wind	150	100
Ocean Thermal Electric Conversion	150	150
Bioconversion	-	40

Of the total funding level, $882,000 was appropriated from the general revenues of Hawaii and $905,000 from the general obligation bond fund.

New York: A 8620

This law reconstitutes the New York State Atomic and Space Development Authority and designates it as the New York State Energy Research and Development Authority (ERDA). The purpose of the New York ERDA is to develop and implement technologies for energy conservation and new energy sources, specifically noted as solar, wind, bioconversion and solid wastes.

The authority has the power to conduct, sponsor or assist research, development and demonstration programs in new energy technologies, which include conservation and the production of power from renewable energy sources. ERDA may join with power companies in the construction and operation of facilities which implement such new energy technologies; it also retains the power of the defunct atomic and space authority to provide such assistance for nuclear and fossil fuel power plants.

The authority's promotion of new energy technologies also includes the provision of services required for the implementation of such technologies to organizations within the state (i.e. business, scientific, public interest, educational, and governmental). The law does not specify the "provisions of services" beyond granting ERDA the power to provide "facilities not otherwise available within the state." To complete its functions in fostering the development and use of new energy technologies, the New York ERDA is to accumulate and disseminate related information and to advise the legislature of recommendations for implementing energy conservation or new energy sources.

The authority has the power to issue revenue bonds which are exempt from state taxes (but are not general obligations of the state) for the purpose of constructing and operating facilities which develop or demonstrate new

energy technologies. The legislature has also appropriated to ERDA the revenue from a state tax on gas and electric corporations of .6 cents per one-thousand cubic feet of gas, or .006 per kilowatt-hour of electricity sold intrastate by such corporations in the last preceding year. The revenue from these utility charges is estimated to be between eight and nine million dollars for this fiscal year.

The authority is to be governed by a board of eleven members. The chairman of the public Service Commission, the commissioner of the Department of Environmental Conservation, and the chairman of the New York Power Authority serve as ex officio members. The remaining eight members are appointed by the governor with the advice and consent of the

Senate for terms of six years. Significant attention was given to the designation of member qualifications. It is specified that of the eight appointees there must be: an engineer or scientist not employed in the nuclear fission field three years prior to appointment; an economist who has not received more than one-tenth of his income from an electric utility during the prior three years; a member of a non-profit environmental group; a member of a non-profit consumer group; and an officer of an electric utility. In addition, the current members of the New York Atomic and Space Development Authority serve out their terms with the successor Energy Research and Development Authority.

E. Life-Cycle Cost Analyses

Florida: Chapter 74-187

The "Florida Energy Conservation in Buildings Act of 1974" requires that life-cycle cost analyses be made prior to the construction of state owned buildings and prior to the leasing of private buildings for state use. Life-cycle costs are defined as the costs of owning, operating and maintaining a facility over the life of the structure. The application of life-cycle costing is intended to facilitate minimized consumption of energy in state owned or operated buildings and also to provide a model for future use in the private sector.

In compliance with this law, state agencies are prohibited from constructing or from having constructed buildings 5000 square feet or greater in area without securing a qualified life-cycle cost evaluation from the Division of Buildings Construction and Maintenance of the Department of General Services. Construction may not proceed until the evaluation of life-cycle costs and the capitalization costs of the initial construction for the facility are disclosed. The life-cycle costs are specified as a primary consideration in selection of building design. Neither may areas 20,000 square feet or greater within a given building boundary be leased until a life-cycle analysis is performed, and a lease may only be made if the life-cycle costs are minimal compared to other available facilities.

The Division of Building Construction and Maintenance is charged with developing rules and procedures for determining life-cycle costs for buildings. Energy consuming equipment of a building and the operating characteristics of subportions of the structure are to be analyzed in life-cycle cost comparisons with other alternative systems. Other features of the anlaysis of fuel and building costs are specified to include insulation, fenestration, and building site-orientation.

The Division is also to promulgate energy performance indices (EPI) as means to evaluate alternate structures and designs. An EPI number is to correspond to the energy required per square foot of floor space (or per cubic foot of volume occupied) under defined internal and external ambient conditions for an entire seasonal cycle.

The rules, procedures and indices developed by the Division are effective 270 days after the bill's enactment and are to be updated annually.

$100,000 is appropriated to the Department of General Services for the purposes of the act, which became effective July 1, 1974.

F. Solar Provisions in State Building Codes

Florida: S.B. 158 (1974)

The state building code was amended to require that all new single-family residential construction must incorporate readily accessible plumbing which permits easy future addition of a solar heating device to the home's hot water system. The state has interpreted this law as requiring a T-pipe fitting on the inlet water pipe of the water heating unit. This code provision for solar retrofitting does not presume the future solar collector to be either a roof or a ground mounted system, and therefore does not require any special orientation or structural considerations for the placement of the collector device.

G. Access to Incident Solar Energy

Oregon: H.B. 2036

This act provided that access to incident sunlight necessary for solar utilization be inlcuded as a consideration upon which any comprehensive plan, zoning, subdivision or other ordinance affecting land use shall be based. It also allows county planning commissions to recommend ordinances which protect and ensure access to incident solar energy or which govern the height and setback of buildings.

City planning commissions are permitted to recommend to the city council zoning ordinances which limit the height, area, and bulk of buildings (this provision supersedes a previous consideration which concerned zoning districts); and may also recommend public incentives for overall energy conservation.

A city council may include setback limits in its building regulations. It may also include solar exposure as a consideration in its open space regulations. The law prohibits city councils from unreasonbaly restricting construction where site conditions are unconducive to solar energy collection, except that an existing solar structure's sun plane shall not be substantially impaired by such construction. Finally, in view of the considerable controversy involving limitations on individual rights of property, the bill requires city councils to exercise the powers granted to them so as to preserve constitutional rights.

Colorado: SB 95

This enactment created solar easements for the purpose of guaranteeing the exposure of a solar energy device to incident sunlight during the entire year. While the state does not require such easements, it does provide the legislative recognition necessary to give solar easement agreements legal standing.

The law requires that the solar easement be subject to the same conveyance and recording requirements as other easements. The legal instrument granting the easement must speicfically include: the vertical and horizontal angles which define the extent of the solar easement; any terms or conditions under which the easement is granted or can be terminated; or any provisions for compensating the owner of the property subject to the use limitations necessary to maintain the easement.

H. Solar Energy Informational and Promotional Activities

Arizona: S.B. 1018 (Chapter 20)

This act establishes the Solar Energy Research Commission, whose purpose is to encourage solar energy development within the state and to promote Arizona as the site for the national solar energy research institute. The commission consists of fifteen voting members, designated as follows: the chairman of the Arizona Power Authority; three (3) persons appointed by the governor, one each from the faculites of the University of Arizona, Arizona State University, and Northern Arizona University; and eleven (11) additional persons appointed by the governor based on their knowledge or commercial involvement with specific solar energy technologies. The president of the Arizona Senate and the speaker of the House of Representatives, or their representatives, are ex officio members of the commission. The chairman of the commission is selected by the governor from among the members, and appointments by the governor expire on the termination date of the act.

An executive director responsible to the commission is to be appointed by the governor with authority to employ necessary personnel to perform the commission's duties. The primary mandate is to initiate and develop a systematic plan for

locating the national solar energy research institute in Arizona which meets all the requirements pursuant to the U.S. Solar Energy Research and Demonstration Act of 1974. This plan is to include recommendations for the organization structure of the national institute. If Arizona is selected as the site, the commission is to fully cooperate in the institute's establishment.

The commission must also assist the efforts of research institutions, local government, and home builders in obtaining technical and financial support from the federal government for their solar and alternative energy activities. This encouragement is offered, in part, through the provision of information and data on private, state, federal and foreign developments concerning solar energy technology. Additionally, the commission is to identify and describe solar energy technologies that may be feasibly implemented within five years; and to similarly identify and describe long-range programs requiring significant technological development that are feasible in a time period from the present through the year 2000.

The executive director is to submit interim reports to the governor and legislature during June 1975, June 1976, and June 1977, with a final report during December 1978; these reports are to include specific recommendations necessary for the support of the national solar energy research institute and any of its satellites.

$75,000 is appropriated to the commission, with any unencumbered or unexpended monies to revert to the general fund on December 31, 1978, at which time the act will expire and the commission be terminated.

Virginia: H.B. 1809 (Chapter 331, Laws of 1975)

The act creates a Virginia Solar Energy Center as part of the Science Museum of Virginia. The purposes of the center are to serve as a clearinghouse for general and technical information on solar energy; and to coordinate programs on solar energy with other state agencies and institutions, and with other states and federal agencies. Other duties of the center include promoting cooperation between Virginia business, industry, agriculture and the public concerning solar utilization; and developing educational programs on solar energy for schools and the general public. The final element of the center's function is to provide assistance in developing policies which would facilitate the implementation of solar energy technologies.

Although no appropriations were specifically made to the center, the intent of the act is to provide an organization which could receive non-state funds to accomplish the purposes set out for the center.

I. Solar Energy System Standards

Florida: Chapter 76-246, 1976

Directs the Florida Solar Energy Center to set standards for solar energy systems manufactured or sold in the state, and to set testing criteria and fees. All solar energy systems sold or manufactured in the state that meet the established standards may display accepted results of approved performance tests. Also, the Department of Education is directed to plan a pilot program for utilization of solar energy in the public schools.

J. Miscellaneous

California: AB4032, 1976

Existing law provides that no public utility shall raise or alter any classification, contract, practice, or rule as to result in any increase in any rate except upon a showing before the Public Utilities Commission (PUC) and a finding by the commission that such increase is justified. This legislation adds to such a provision that upon showing before the PUC and before a public hearing that a public utility has invested in projects designed to generate or produce energy from renewable sources or has invested in other systems capable of meeting the then applicable environmental pollution standards, in either case generating energy for commercial purposes, the PUC may allow a return on such an investment one-half to one percent higher than the return allowed on the utility's other investments. The PUC may also provide a higher rate of return on capital investments by a public utility in experimental projects which are designed to improve or perfect technology to generate energy from renewable resources, or to more efficiently utilize other resources for the generation of energy in a manner which will decrease the environmental pollution per unit of energy generated or produced.

Rhode Island: S2465, 1976

Creates a special legislative commission to be called the state energy technology study commission to study solar energy and wind energy as available energy sources and the related technology.

APPENDIX C

SOLAR/UTILITY INTERFACE STUDIES

APPENDIX C

Solar/Utility Interface Studies, from "Analysis of Policy Options for Accelerating Commercialization of Solar Heating and Cooling Systems", R. Bezdek, et al, Program of Policy Studies in Science and Technology; George Washington University, Washington, D.C., April 1977, p.458.

A number of problem areas in the solar/utility interface have been identified by the National Science Foundation of the United States and have been given priorities for research. These include:

i. The impact of public utility rate structures on the market penetration of solar energy;

ii. the impact of solar energy space conditioning and water heating on competing and complementary industries; and

iii. the supply, ownership, and/or manufacture of solar energy equipment by public utilities.

Table III-1 summarizes the participants, the nature of the work, and the area of interface consideration.

TABLE III - 1

A SUMMARY OF WORK ADDRESSING THE SOLAR UTILITY INTERFACE

PAPER/STUDY PROJECT[1]	PARTICIPANTS	SCOPE OF WORK[2]	BRIEF DESCRIPTION
1. (P) Sage	Southern California Gas Co./ Jet Propulsion Laboratory	RD + D	Solar Hot Water Heating
2. (S) Non-Conventional Incentives for Adoption of Solar Energy	Clark University/ Total Environmental Action	R	Impact of Pricing Upon SHAC Systems
3. (S) Implications of Solar Space Conditioning on Utilities	Franklin Institute Research Laboratories	R	Impact of SHAC Systems Upon Utilities
4. (P) Assessment of Solar Heated Buildings & Collectors	Thayer School of Engineering, Dartmouth College	RD + D	Demonstration and Monitoring of SHAC System
5.	Energy Research Institute of Puerto Rico Water Resources Authority	RD + D	Impact of Solar Cooling and Water Heating Upon Utilities.
6. (P)	Department of Natural Resources Commonwealth of Puerto Rico	RD + D	Demonstration of Industrial Solar Space Cooling
7. (P) Solar Assisted Heating & Cooling Demonstration	ERDA/EPRI/PEPCO/Westinghouse	RD + D	Residential Demonstration of Solar Assisted Off-Peak Heating and Cooling System

1 Pa = Paper; S = Study or Contract, P = Project - Titles are Abridged.

2 R = Research; R + D = Research and Development; RD + D = Research, Development, and Demonstration

TABLE III - 1

A SUMMARY OF WORK ADDRESSING THE SOLAR UTILITY INTERFACE

PAPER/STUDY PROJECT 1	PARTICIPANTS	SCOPE OF WORK 2	BRIEF DESCRIPTION
8. (S)	CONAES	R	Inter-relationship Between Energy Conservation Nuclear, and Alternative Energy
9. (S) Preliminary Survey of Utility Solar Projects	EPRI	R	Solar Activity Among EPRI Utility Members
10. (P) Individual Load Center SHAC Project	A.D. Little, Inc.	RD + D	Development and Demonstration of SHAC Residential Systems
11. (S) SHAC Requirements Definition and Impact Analysis	Aerospace Corporation	R	Determination of Impacts of SHAC Systems Upon Utility
12. (P) Individual Load Center SHAC Commercial		RD + D	Development and Demonstration of SHAC Commercial Systems
13. (S) Solar Assisted Heat Pump Load Management Project		R	Comparison of Energy Conservation in Design, Load Management and Solar Auamentation
14. (S) Investigation to Improve Westinghouse Heat Pump Performance	Westinghouse	R + D	Development of more efficient and reliable heat pumps for SHAC Systems.

1 Pa = Paper; S = Study or Contract, P = Project - Titles are Abridged.

2 R = Research; R + D = Research and Development; RD + D = Research, Development, and Demonstration.

TABLE III - 1

A SUMMARY OF WORK ADDRESSING THE SOLAR UTILITY INTERFACE

	PAPER/STUDY PROJECT 1	PARTICIPANTS	SCOPE OF WORK 2	BRIEF DESCRIPTION
15.	(S) Solar Materials and Components Test Facility	Black and Veatch/ Georgia Technical Research Institute	R + D	Development and Design of a Solar Components Test Facility
16.	(P) Minimum Energy Dwelling	Southern California Gas Co./ERDA/Mission Viejo Company	RD + D	Development and Demonstration of Residential Energy Conservation Systems
17.	(P)	New England Electic System	RD + D	Installation and Monitoring of Residential Solar Hot Water Systems
18.	(S) Solar Climate Control, Storage, and Land Management	A.D. Little, Inc.	R	Model Utility Impacts of SHAC
19.	(Pa) Resource Allocation Under Regulatory Scenarios	H. Craig Petersen	R	Regulatory effects on resource allocations between electric and solar energy
20.	(S) Assessment of SHAC for an Electric Utility	Southern California Edison Co./JPL	R	Assessment of SHAC Systems from Utility and Consumer Positions
21.	(P) Assessing Potential for Utilization of Off-Peak Power	Westinghouse	RD + D	Development and Demonstration of Off-Peak Energy Utilization Systems

1 Pa = Paper; S = Study or Contract, P = Project - Titles are Abridged.

2 R = Research; R + D = Research and Development; RD + D = Research, Development, and Demonstration.

BIBLIOGRAPHY AND REFERENCES

The specific references made by numbers in parentheses in the text are listed here in sequence, in accordance with their respective Section and Sub-section designations.

References and Bibliography of general interest on the topic are listed in the final Bibliography.

SECTION I - INTRODUCTION

1. The Impact of Solar Heating on Electrical Generation in Ontario; IBI Group, prepared for the Royal Commission on Electric Power Planning, 1977, p.3

2. Legal, Political, Social and Ecological Considerations; Joan B. Berkowitz and Peter R. Glaser; ASHRAE GRP 170; 1977, p.II-1

2. The IBI Group has done a comprehensive report on effects of solar heating systems on utility peak loads and load factors, see n.1

SECTION II - GOALS AND OBJECTIVES OF A SOLAR HEAT UTILIZATION PROGRAM

1. Analysis of Policy Options for Accelerating Commercialization of Solar Heating and Cooling Systems - R. Bezdeck, et al, Program of Policy Studies in Science and Technology; George Washington University, Washington, D.C., April 1977, p.458.

2. Ibid.

3. Ibid, p.457.

4. New Laws to Encourage Solar Energy Use for Individual Buildings, R. L. Robbins, Lake Michigan Federation; Chicago, Ill., June 1976, Appendix 2, p.3.

5. Ibid.

6. Goals and Objectives of a Solar Energy Program - ERDA; February 1976.

7. See n.4, Appendix 6, pp. 9, 10.

8. Ibid.

9. Ibid,

10. Ibid, p.11.

11. Ibid, Appendix 13, pp. 19-20

12. Ibid.

13. Ibid.

14. Ibid.

15. Ibid.

16. Ibid, p.21

17. Ibid.

18. Solar Total Energy Systems, Solar Program Assessment Environmental Impacts; ERDA, March, 1977, p.53.

SECTION IV-1 IMPROVING THE PRIVATE SECTOR ECONOMICS OF SOLAR HEATING SYSTEMS

1. Ministry of Treasury, Economics, and Intergovernmental Affairs, 1977.

2. Solar Heating: An Estimate of Market Penetration; submitted to the RCEPP, March 1977, p.9.

3. Ibid, p.12.

4. Ibid, p.9.

5. Ibid, p.12.

6. Application of Solar Energy for Heating and Cooling of Buildings, "Legal, Political, Economic, Social and Ecological Considerations", Joan B. Berkowitz, and Peter E. Glaser; ASHRAE GRP 170; 1977, p. II-1.

7. See n.2, p.47.

8. Ontario Hydro Statistical Yearbook, 1975.

9. Ibid.

10. See n.1

11. New Laws to Encourage Solar Energy Use for Individual Buildings, R. L. Robbins, Lake Michigan Federation, Chicago, Ill, June 1976, Appendix 3, p.4

12. Implementing a Solar Energy Technology in Canada: The Costs, Benefits, and Role of Government; M. K. Berkowitz - The Institute of Policy Analysis, University of Toronto, for the Department of Energy, Mines, and Resources, May 1977, p.28.

13. *Analysis of Policy Options for Accelerating Commercialization of Solar Heating and Cooling Systems*; R. Bezdeck, et al; Program of Policy Studies in Science and Technology; George Washington University, Washington, D.C., April 1977, p.48.

14. See n.12, p.194

15. *Legal Barriers to Solar Heating and Cooling of Buildings - Environmental Law Institute*; Washington, D.C. March 1977, p.158

16. See n.12, p.32

17. See 13, p.126

18. Ibid.

19. See n.12, p.32

20. See n.15, p.161

21. Ibid, p.162

22. Ibid.

23. Ibid.

24. Ibid.

25. Ibid.

26. See n.13, p.12

27. See n.11, Appendix 4, p.5

27. Project Independence; Federal Energy Administration; Interagency Task Force on Solar Energy, under Direction of National Science Foundation; November 1974, Appendix III, p.A-II-1

28. See n.13, p.51

29. See n.12, p.131

30. See n.11, Appendix 4, p.6

31. Ibid.

32. See n.13, p.127

34. Ibid, p.50

35.& 36. Solar Engineering Magazine, May 1977 - "Will Carter Energy proposal put solar on the home stretch?" p.5

37. Ibid, p.129

38. Ibid. p.128

39. See n.12, p.192

40. See n.11, Appendix 4, p.5

41. See n.13, p.51

42. Ibid, p.53

43. Ibid, p.54

44. Ibid, p.67

45. See N.16, p.176

46. Fred Hyndman of Hyndman Insurance Co., - Charlottetown, P.E.I.

47. See n.13, p.58

48. See 28. Appendix III, p.A-III-1

49. See n.13, p.64

50. See n.13, p.65

51. Ministry of Industry, Trade and Commerce.

52. See n.13, p.59

53. Phillip Cockshutt; National Research Council - from an article in the Toronto Sun - "You Can't Sue Neighbour for Stealing Sunlight" - Saturday, July 23, 1977.

SECTION IV-2 - IMPROVING THE FINANCIAL CLIMATE FOR PURCHASING SOLAR HEATING SYSTEMS

1. Home Mortgage Lending and Solar Energy - prepared by Regional and Urban Planning Implementation, Inc.(RUPI) Cambridge, Massachusetts; for the U.S. Department of Housing and Urban Development, in cooperation with the U.S. Energy Research and Development Administration; February 1977, p.7

2. Analysis of Policy Options for Accelerating Commercialization of Solar Heating and Cooling Systems - Roger Bezdek et al; Program of Policy Studies in Science and Technology; George Washington University, Washington, D.C., April 1977, p.326

3. New Laws to Encourage Solar Energy Use for Individual Buildings - R. L. Robbins, Lake Michigan Federation, Chicago, Ill, June 1976, p.19

4. Some Institutional Problems of Residential Solar Heating - J. F. Blair, Jr., J. O'Brien - from the "Sharing the Sun: Solar Technology in the Seventies" joint conference of the American Sector of ISES, and SESC, Inc., Winnipeg, August 1976, Vol. 9; p.196

5. See n.1, p.13

6. See n.1, p.12

7. Ibid.

8. See n.1, p.14

9. See n.1, p.15

10. Ibid.

11. Ibid.

12. Ibid.

13. See n.1, p.16

14. Ibid.

15. Ibid.

16. Ibid.

17. See n.2, p.327

18. Ibid.

19. Legal Issues Related to Use of Solar Energy Systems - W. Thomas, A. Miller, R. Robbins; The American Bar Foundation Research Journal, August 1976.

20. See n.2, p.328

21. See n.2, p.330

22. Ibid.

23. See n.1, p.23

24. See n.2, p.333

25. See n.2, p.334

26. See n.1, p.23

27. Ibid.

28. See n.2, p.334

29. See n.2, p.335

30. See n.1, p.29

31. <u>Project Independence; Federal Energy Administration; Interagency Task Force on Solar Energy</u>, under Direction of National Science Foundation; November 1974, Appendix III, p. A-III-4

32. See n.1

33. See n.1, p.6

34. See n.1, p.29

35. See n.1, p.30

36. See n.1, pp. 30, 31

SECTION IV-3 - THE INTERFACE BETWEEN SOLAR HEATING SYSTEMS AND PUBLIC UTILITIES

1. Ontario Hydro's Statistical Yearbook 1975.

2. Impact of Solar Heating on Electrical Power Generation in Ontario; IBI Group; prepared for the Royal Commission on Electrical Power Planning, 1977, p.3

3. Legal Barriers to Solar Heating and Cooling of Buildings; Environmental Law Institute; prepared for the U.S. Energy Research and Development Administration; Washington, D.C., March 1977, p.94

4. Analysis of Policy Options for Accelerating the Commercialization of Solar Heating and Cooling Systems; R. Bezdek, et al; George Washington University; Washington, D.C., April 1977, p.169

5. Monthly Rates and Comparative Bills; Ontario Hydro and Associated Municipal Utilities, January 1977.

6. See n.4, p.170

7. See n.5

8. Ibid.

9. Ibid.

10. See n.4, p.171

11. See n.4, p.177

12. See n.4, p.194

13. Obtained from the staff of the Royal Commission on Electric Power Planning.

14. See n.4, p.194

15. Report on Load Management Possibilities; Leighton and Kidd, prepared for the Royal Commission on Electric Power Planning, June 1976, p.67.

16. See n.4, p.220

17. Public Utilities Consider Solar Energy; Sunworld, July 1976, pp.10, 11.

18. See n.4, p. 221

19. See n.4, p.223

20. The Economics of Regulation, Vol. I ("Principles") and Vol. II ("Institutional Issues") - Alfred E. Kahn; Wiley - 1970 and 1971.

21. See n.4, p.224

22. Regulating Prices in Competitive Markets; Yale Law Journal, Vol. 82, No. 7, E.G. Noll; and L. Rivlin - June 1973, pp.1426-1434.

23. Ibid.

24. See n.4, p.226

25. Ibid.

26. See n.4, p.104

27. See n.4, p.229

28. Ibid.

29. National Conference of State Legislators, Analysis of State Solar Energy Policies, prepared for the FFA.

30. Studies in Electrical Utility Regulation; Charles J. Circhetti and John Jurewitz, Ballinger Publishing Co.

31. See n.4, p.234.

SECTION IV-4 - IMPROVING ACCESS TO SOLAR INSOLATION

1. Application of Solar Technology to Today's Energy Needs; Office of Technology Assessment; Congress of the United States, Washington, D.C., June 1977 page VI-4

2. Ibid; p. VI-5

3. Ibid; p.VI-6

4. Legal Barriers to Solar Heating and Cooling of Buildings; Environmental Law Institute; Washington, D.C. March, 1977; p.15

5. Solar Total Energy Systems - Solar Program Assessment; Environmental Impacts; ERDA, March 1977, p.55

6. See n.1; p.VI-8

7. Analysis of Policy Options for Accelerating Commercialization of Solar Heating and Cooling Systems - R. Bezdeck et al; Program of Policy Studies in Science and Technology; George Washington University, Washington, D.C., April, 1977, p.281

8. New Laws to Encourage Solar Energy Use for Individual Buildings - R. L. Robbins; Lake Michigan Federation, Chicago, Ill., June 1976, Appendix 10, p.16

9. Policies Plan, Albequerque/Bernalillo County Planning Department; April 1975; page 24-25

10. See n.1, p. VI-16

11. See n.7; p. 271

12. Solar Rights: New Law for a New Technology. S.F. Kraemer and J. G. Felt

13. See n.7; p.272

SECTION IV-5 - BUILDING CODES

1. Legal Barriers to Solar Heating and Cooling of Buildings - Environmental Law Institute; Washington, D.C., March 1977, p.50

2. Ibid, p.50

3. Analysis of Policy Options for Accelerating Commercialization of Solar Heating and Cooling Systems, R. Bezdeck, et al; Program of Policy Studies in Science and Technology; George Washington University, Washington, D.C. - April 1977, p. 414

4. See n.3, p.435

5. Solar Total Energy Systems - Solar Program Assessment Environmental Impacts; ERDA, March 1977, P.50

SECTION V - CONCLUSION

1. Applications of Solar Energy for Heating and Cooling of Buildings - "Legal, Political, Economic, Social and Ecological Considerations". J. B. Berkowitz and P. E. Glaser; ASHRAE GRP 170, 1977, p.II-6

2. Ibid.

3. Ibid; p.II-10

4. New Laws to Encourage Solar Energy Use of Individual Buildings, R. L. Robbins, Lake Michigan Federation; Chicago, Ill. June 1976, p.20

5. Ibid.

6. Impact of Solar Heating on Electric Power Generation in Ontario - submitted to the ECEPP; IBI Group 1977.

REFERENCES

Aitken, D. W.; et al - "Institutional Considerations for Solar Energy Systems Planning and Applications. Case Example: San Jose State University "Project Helios'". San Jose State University, Cal., 1977.

Albuguerque/Bernalillo County Comprehensive Plan - "Policies Plan" - April, 1975.

Ashburn, J. G. and Mueller, R. O. - "Solar Energy and Electric Utilities: Should They be Interfaced?" Science; Vol. 195, No. 4277, February 1977.

Barrett, D; Epstein, P.; Harr, C. M. - "Home Mortgage Lending and Solar Energy" - Regional and Urban Planning Implementation, Inc., Cambridge, Mass., prepared for the U.S. H.U.D. and ERDA, February 1977.

Berkowitz, J. B.; Glaser, P. D. - "Legal, Political, Economic, Social and Ecological Considerations" - ASHRAE GRP 1970, Applications of SOlar Energy for Heating and Cooling of Buildings, 1977.

Berkowitz, M. K. - "Implementing a Solar Technology in Canada: The Costs, Benefits, and Role of GOvernment." University of Toronto, for the Department of Energy, Mines,and Resources, May 1977.

Bezdek, R; et al - "Analysis of Policy Options for Accelerating Commercialization of Solar Heating and Cooling Systems" - George Washington University, Washington, D.C., April 1977.

Bezdek, R. H.; Ezra, A. A. - "Assessment of Incentives to Accelerate Market Penetration of Solar Heating and Cooling Systems, U.S. Energy, Research and Development Administration, Washington, D.C., 1977.

Blair, J.; O'Brien, J. - "Solar Institutional Problems of Residential Solar Heating", proceeding from the Sharing of the Sun Conference, Winnipeg, Col. 9, 1976.

Braun, G. W.; et al - "Assessment of Solar Heating and Cooling for an Electric Utility Company" - Southern California Edison Company, August 1975.

Dickinson, W. C.; Freeman, H. J. - "The Economic Viability of Solar Assisted Industrial Process Heat Systems: The Need for Government Economic Incentives", from proceedings of the 1977 Annual Meeting, American Section of the International Solar Energy Society, June 1977.

Dooley, J. E. - "Review of the Energy Demand Forecasting Methods Used by the Ontario Hydro and the Ministry of Treasury, Economics, and Intergovernmental Affairs, prepared for the RCEPP, April 1977.

Environmental Law Institute - "Legal Barriers to Solar Heating and Cooling of Buildings" - prepared for the U.S. Energy, Research and Development Administration, March 1976.

Eisenhard, R. M. - "Survey of State Legislation Relating to Solar Energy" - National Bureau of Standards, Washington, D.C., April 1976. NBSIR -76-1082.

Hooker, C. A.; van Hulst, R. - "Institutions, Counter-Institutions and the Conceptual Framework of Energy Policy Making in Ontario", prepared for the RCEPP, May 1977.

Howe, E. D. - "Public Utilities Consider Solar Energy" - Sunworld; International Solar Energy Society; Number 1, July 1976.

IBI Group; "Solar Heating: An Estimate of Market Penetration" prepared for the Royal Commission on Electric Power Planning, March 1977.

IBI Group; "Impact of Solar Heating on Electric Power Generation in Ontario"- prepared for the Royal Commission on Electric Power Planning, July 1977.

Johnson, A. C. - "Commercialization of Solar Heating and Cooling of Buildings" - from Proceeding of Solar Cooling and Heating: A National Forum - Miami Beach, Florida, 1976.

Kraemer, S. F.; Felt, J. G. - "Solar Rights - New Law for a New Technology", Colorado Springs, Colorado - 1977.

Leighton and Kidd Limited - "Report on Electrical Load Management Possibilities" - prepared for the Royal Commission on Electric Power Planning - June 1976.

Lorsh, H. G., "Effect of Solar Home Heating on Electric Utilities" - proceeding from the Sharing the Sun Conference, Winnipeg, Vol.9, 1976.

Masterson, C. "Barriers and Incentives to the Widespread Utilization of Solar Energy for the Heating and Cooling of Buildings" - from proceeding of Solar Cooling and Heating: A National Forum - Miami Beach, Florida, 1976.

McConnell, R. D.; et al, "The Use of Off-Peak Electricity for Solar Heated Homes" - proceeding from the Sharing the Sun Conference, Winnipeg, Vol.9, 1976.

Middleton Associates - "Canada's Renewable Energy Resources: An Assessment of Potential" - prepared for the Department of Energy, Mines, and Resources, Ottawa, 1976.

Ministry of Consumer and Commercial Relations, "The Building Code", Ontario, 1974.

Ministry of Energy, Mines and Resources. Submission to the Royal Commission on Electric Power Planning, May 1976.

Office of Technology Assessment - "Application of Solar Technology to Today's Energy Needs" - prepared for the Conference pf the United States, June 1977.

Ontario Hydro; "Monthly Rates and Comparative Bills Ontario Hydro and the Associated Municipal Utilities", January 1977.

Peterson, H. C. - "The Impact of Tax Incentives and Auxiliary Fuel Prices on the Utilization Rate of Solar Energy Space Conditioning" - Utah State University for the National Science Foundation, January 1976.

Project Independence - by the Interagency Task Force on Solar Energy, under direction of the National Science Foundation, November 1974.

Reid, R. L.; Hendricks, R. C. - "Effect of Tax Credits on the Economics of Solar Heating for Homeowners" - from proceedings of the 1977 Annual Meeting American Section of the International Solar Energy Society, Orlando, Florida, June 1977.

Robbins, R. L. - "New Laws to Encourage Solar Energy Use for Individual Buildings" - Lake Michigan Federation, Chicago, Ill., June 1976.

The Royal Commission on Electric Power Planning issue papers on:
- Financial and Economic Factors
- Transmission and Distribution
- Conventional and ALternate Generation Technology
- Land Use
- Impact of Rate Structures and Rate Levels
- The Demand for Electric Power.

Slater, K. J. "Ontario Hydro's Planning Concepts" prepared for the RCEPP, 1976.

U.S. Energy Research and Development Administration; "Solar Total Energy Systems" - March 1977.